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CONDITION SURVEY, MINOT AIR FORCE BASE, NORTH DAKOTA.(U)
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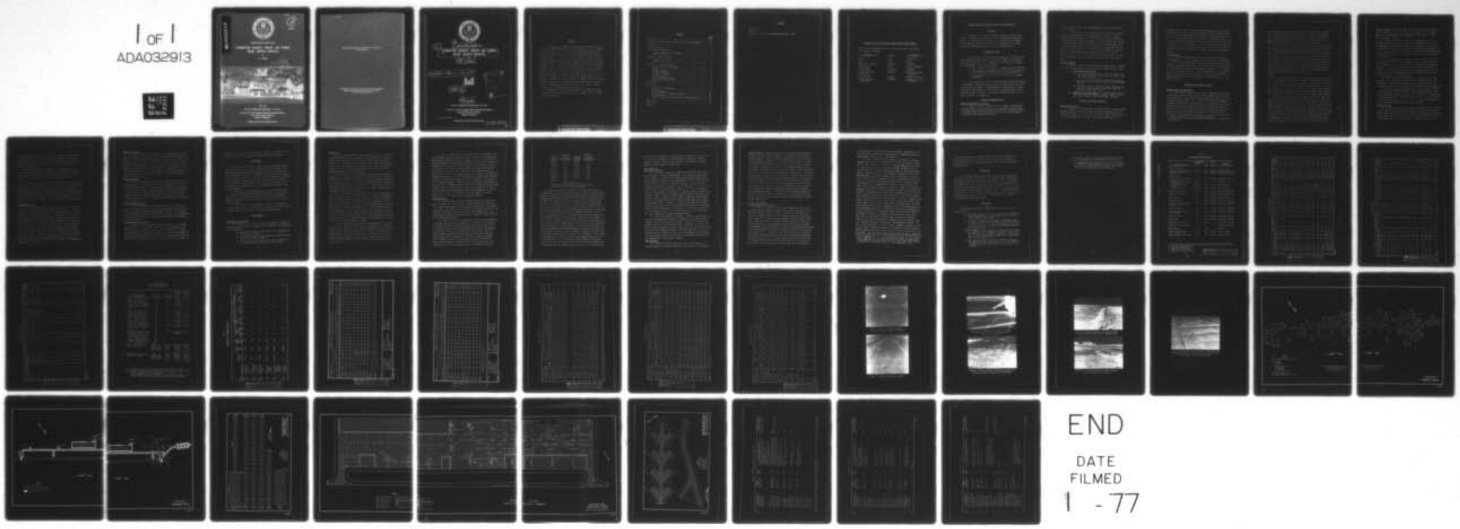

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MISCELLANEOUS PAPER S-73-23

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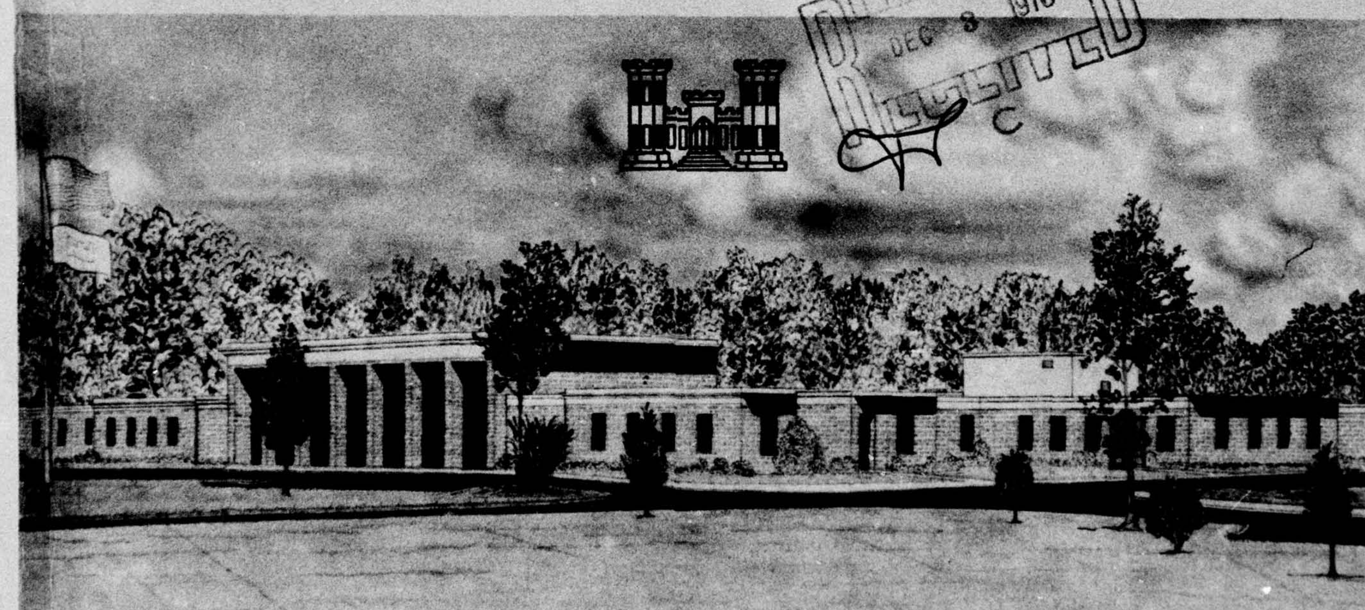
by

P. J. Vedros



April 1973

Sponsored by Office, Chief of Engineers, U. S. Army

Conducted by U. S. Army Engineer Waterways Experiment Station
Soils and Pavements Laboratory
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ARMY-MRC VICKSBURG, MISS

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Foreword

The study reported herein was conducted under the general supervision of the Engineering Design Criteria Branch, Soils and Pavements Laboratory, of the U. S. Army Engineer Waterways Experiment Station (WES), Vicksburg, Mississippi. Personnel involved in the condition survey were Mr. T. C. Johnson of the U. S. Army Cold Regions Research and Engineering Laboratory (CRREL), Hanover, New Hampshire; Mr. George Schanz of the U. S. Army Construction Engineering Research Laboratory, Champaign, Illinois; Messrs. H. H. Baker, J. C. Hart, and Ralph Strong of the U. S. Army Engineer Division, New England, Waltham, Massachusetts; and Messrs. P. J. Vedros, R. D. Jackson, H. T. Thornton, Jr., S. J. Alford, and K. A. O'Conner of the WES. The main portion of this report was prepared by Mr. Vedros under the general supervision of Messrs. J. P. Sale, R. G. Ahlvin, and R. L. Hutchinson of the Soils and Pavements Laboratory. The section of this report concerning frost action was prepared by Mr. Johnson and by Mr. G. D. Gilman of CRREL. Appendix A was obtained from the Air Force.

COL Ernest D. Peixotto, CE, was Director of the WES during the conduct of the study and preparation of the report. Mr. F. R. Brown was Technical Director.

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Appendix A: MAFB Annual Pavement Maintenance Plan

Conversion Factors, British to Metric Units of Measurement

British units of measurement used in this report can be converted to metric units as follows:

Multiply	By	To Obtain
inches	2.54	centimeters
feet	0.3048	meters
miles (U. S. statute)	1.609344	kilometers
square inches	6.4516	square centimeters
pounds (mass)	0.45359237	kilograms
pounds (force) per square inch	0.6894757	newtons per square centimeter
miles per hour	1.609344	kilometers per hour
pounds (mass) per cubic inch	0.0276799	kilograms per cubic centimeter

CONDITION SURVEY, MINOT AIR FORCE BASE, NORTH DAKOTA

Authority

1. Authority for conducting condition surveys at selected airfields is contained in amendment to FY 1972 RDTE Funding Authorization (MFS-MC-5, 16 February 1972), subject: "Air Force Airfield Pavement Research Program," from the Office, Chief of Engineers, U. S. Army, Directorate of Military Construction, dated 18 February 1972.

Purpose and Scope

2. The purpose of this report is to present the results of a condition survey performed at Minot Air Force Base (MAFB), North Dakota, during 11-15 April 1972. The following three major areas of interest were considered in this condition survey:

a. The structural condition of the primary airfield pavements.

b. The condition of pavement repairs and the types of maintenance materials that have been used at this airfield.

c. Any detrimental effects of frost action to the pavement facilities.

3. This report is limited to a presentation of visual observations of the pavement conditions, discussion of these observations, and pertinent remarks with regard to the performance of the pavements. No physical tests of the pavements, foundations, or patching materials were performed during this survey. The annual pavement maintenance plan for MAFB is presented in Appendix A.

Pertinent Background Data

General description of airfield

4. MAFB is located in Ward County, North Dakota, approximately 15 miles* north of the city of Minot. The general topography of the

* A table of factors for converting British units of measurement to metric units is presented on page vii.

site is gently rolling, and the average elevation is 1,668 ft above mean sea level.

5. In April 1972, the airfield facilities consisted of a NW-SE runway, a parallel taxiway, a SAC operational apron with a hangar access taxiway and apron, a SAC alert facility, an ADC parking apron with hangar access aprons and taxiways, an ADC alert apron and taxiway, two warm-up aprons, connecting taxiways to the runway and aprons, and a missile loading facility. The runway was 300 ft wide and 13,200 ft long; the taxiways were 75 ft wide, with 50-ft shoulders on each side; and the SAC operational apron was approximately 600 ft wide and 3,011 ft long. A layout of the airfield is shown in plate 1. A pavement plan indicating the type pavement on each facility is shown in plate 2.

Previous reports

6. Previous reports concerning MAFB are listed below. Pertinent data were extracted from them for use in this condition survey report.

a. Condition survey reports:

(1) U. S. Army Engineer District, Omaha, CE, "Rigid Pavement Condition Survey of Minot Air Force Base," July 1958, Omaha, Nebraska.

(2) _________, "Rigid Pavement Condition Survey Report, Minot Air Force Base, North Dakota," June 1960, Omaha, Nebraska.

(3) Ohio River Division Laboratories, CE, "Condition Survey Report, Minot Air Force Base, North Dakota," March 1965, Cincinnati, Ohio.

b. Pavement evaluation report: U. S. Army Engineer District, Omaha, CE, "Airfield Evaluation Report, Minot Air Force Base, North Dakota," August 1959, Omaha, Nebraska.

History of Airfield Pavements

Construction history

7. Details of the design and construction history of the airfield pavements (extracted from the reports referenced in paragraph 6) are presented in table 1. In July 1964, the primary taxiway from sta 29+90 to 109+32 (features T11A and T12A) was overlaid with 1-1/2 in. of

asphaltic concrete (AC). The overlay was designed by personnel of the Second Air Force, and construction management was by the Corps of Engineers. A missile loading facility (feature A12B) was constructed in 1965 of 9-in. portland cement concrete (PCC). The taxiway access to the missile loading facility consisted of 3-in. AC and was designed and constructed by the Corps of Engineers. The design loading of this facility was reported to be for a C-141 having a gross load of about 150,000 lb. Pavement thicknesses, descriptions, and other details are presented in table 2.

Traffic history

8. Detailed traffic records were available for the period July 1960-December 1971. Traffic records for the latter part of 1971 indicate that about 80 and 120 cycles* per month were being applied by B-52 and KC-135 aircraft, respectively. There are about 10 cycles per month of C-141 aircraft traffic, and other aircraft (fighters, etc.) account for about 620 cycles per month. It has been reported (see paragraph 6a (2)) that heavy aircraft began operations at MAFB about July 1960. A summary of traffic data for the period July 1960-December 1971 is presented in table 3.

Conditions of Pavement Surfaces

Pavement inspection procedure

9. The following procedure was used in conducting the inspection of the rigid pavements. Representative features were selected for detailed inspection. The features were then inspected slab** by slab, and the defects were recorded. The locations of the individual pavement features, the inspection starting points, and the directions in which the pavements were inspected (shown by arrows) are indicated in plate 1. The results of the rigid pavement survey for those features that were inspected in detail are presented in table 4. This table shows a

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* A cycle of traffic is one landing and one takeoff.

** A slab is the smallest unit, containing no joints, of a given pavement feature.

quantitative breakdown of the various types of defects and a condition rating for each pavement feature inspected in detail. The procedures used for determining the condition rating of a pavement are given in Appendix III of Department of the Army Technical Manual TM 5-827-3, "Rigid Airfield Pavement Evaluation," dated September 1965.

10. It was reported, in trip reports and letter reports in 1958 and 1959 by the Omaha District and the Ohio River Division Laboratories, that concrete pavements constructed at MAFB during the periods 1956, 1957, and 1958 were experiencing cracking during the early curing stages. The cracking was occurring as shrinkage, map, and longitudinal cracks and was caused by conditions related to curing and protection of the concrete during the early hardening period. This cracking phenomenon is mentioned because the cracks are not load associated, and some of the shrinkage cracks have developed into longitudinal structural breaks. A summary of the progression of major defects in pavement features surveyed in 1960 and 1972 is presented in table 4.

Runway

11. In general, the condition of the pavement surface on the runway was considered to be very good to excellent. Approximately 75 percent of the traffic uses the SE (29) end of the runway for takeoffs; and, as is noted in table 5, about 8 percent of the slabs in the first 500 ft of this end of the runway (16- and 18-in. PCC pavements, features R1A and R2B) contained major defects. About 10 percent of the slabs in the second 500 ft, which is 16-in. PCC (feature R2B), contained major defects.

12. The interior portion of the runway (100-ft-wide inlay, features R3C and R4C), which consists of 16-in.-thick PCC, was rated in very good condition in the 1972 survey. Approximately 18 percent of the slabs contained a major structural defect. In a trip report by personnel of the Ohio River Division Laboratories, dated 7 October 1958, it was stated that a fine, longitudinal crack extended continuously through 42 slabs in lane 7 of the runway interior. (In plate 3 these are slabs 345-387.) As is noted in table 4, there was a considerable increase in longitudinal cracking in the runway interior from the 1960 survey to the 1972 survey. The 1960 survey indicated that about 40 slabs

contained shrinkage cracks and that the cracking was fairly evenly distributed over the four paving lanes. As is noted in plate 3, about 75 percent of the structural defects counted in 1972 occurred in slabs located in lanes 6 and 7.

13. About 3 percent of the slabs in the first 500 ft of the NW (11) end of the runway (16- and 18-in. PCC pavements, features R5B and R6A) contained major defects, and about 10 percent of the slabs in the second 500 ft (16-in. PCC pavement, feature R5B) contained major defects. As is indicated in table 4, there has been a substantial increase in longitudinal and transverse cracking in this end of the runway since the survey in 1960.

14. The AC pavement on each side of the PCC interior of the runway (feature R7D) was in fair condition, with transverse cracking occurring about every 10 to 15 ft. There was vertical displacement of from 1/2 to 2 in. (i.e., the PCC interior being higher than the AC edges) at the longitudinal joining of the two types of pavements. The cracking and vertical displacement were due to frost action, which is discussed in detail in paragraphs 28-41.

15. There were some aggregate pop-outs observed in the runway pavements, with the majority occurring in the interior section. The maximum size of the voids resulting from the pop-outs was about 3 in. in diameter (photo 1). These areas are kept free of debris by sweeping.

16. Structurally, the pavements seem to be performing satisfactorily under traffic from the B-52's now operating at the base. Nine B-52 pilots and nine KC-135 pilots were asked to rate the riding quality of the runway pavement. Sixty-seven percent of the B-52 pilots rated it as smooth, and the other 33 percent rated it as fair. One hundred percent of the KC-135 pilots rated the runway as smooth.

Primary taxiways

17. The primary heavy-load taxiway system consists of the primary taxiway and the SAC operational apron taxiway. The NW end (5000 ft, feature T1A) and the SE end (1700 ft, features T2A and T3A) of the primary taxiway consist of 16-18-16-in. PCC. These pavements were rated as in very good condition in this survey. As is noted in table 5, the

pavements on the NW end had about 71 slabs with longitudinal cracks and about 34 slabs with shrinkage cracks. Some diagonal and transverse cracks were also noted. Sixteen percent of the slabs of the SE end of the primary taxiway had major defects as opposed to only 11 percent of the slabs of the NW end.

18. The AC portion of the primary taxiway (features T11A and T12A) was in excellent condition, with only a few transverse cracks in the surface. This taxiway was originally constructed of 4-in. AC in 1955-56 and was overlaid in 1964 with an additional thickness of 1-1/2 in. of AC.

19. The taxiway through the SAC operational apron, which consists of 16-18-16-in. PCC was in very good condition. About 15 percent of the slabs contained major defects (table 5), but only about 3 percent of these defects occurred in the taxiway located in the extension to the NW end of the apron (feature T6A). The frequency of major defects was about the same for the 18-in. pavements as for the 16-in. pavements. None of the cracking observed was severe from the standpoint of displacement or faulting.

SAC operational apron

20. The large operational apron consists of 15-in. PCC, with 25- by 25-ft slabs composing the original portion (feature A3B). The overall condition of the apron was very good, with approximately 19 percent of the slabs containing major defects. A comparison of the number of 1972 defects with the number of 1960 defects (table 4) indicates that the original apron (feature A3B) has had a significant increase in the number of defects. Plate 4 shows the locations and types of defects as observed in 1972. It was possible to survey only a few areas where alert aircraft parked. In these areas, considerable distress in the slabs had occurred, especially in those slabs on which aircraft wheels are usually located. Furthermore, vibrations are transferred from the aircraft to the slabs during run-up operations; and, in almost every parking spot, the slabs were shattered, and, in some cases, displacement and faulting had occurred.

SAC alert facility

21. The SAC alert facility consists of a taxiway (feature T13B) and nine parking stubs (feature A8B). The taxiway was in very good condition with about 19 percent of the slabs containing a major structural defect; however, as is shown in plate 5 and table 5, the center taxiing lane was in poor condition in the area adjacent to the parking stubs. Almost every slab in this area was considered to be shattered; i.e., the slabs were cracked into at least six pieces. The alert stubs were in excellent condition, with only about 7 percent of the slabs containing a major structural defect.

ADC parking apron

22. The ADC parking apron (feature A5B), which consists of 16-in.-thick PCC, was in good condition, with about 21 percent of the slabs containing a major defect. The majority of the defects noted were longitudinal cracks. In 1959, it was reported that approximately 13 slabs in this apron contained longitudinal cracking and 6 slabs contained transverse cracking. These pavements were constructed in 1956, and shrinkage and map cracking were prevalent in them during the curing and early hardening period.

NW and SE warm-up aprons

23. The NW warm-up apron (feature A1B) was in very good condition, with about 11 percent of the slabs containing major defects. The defects were mostly longitudinal and diagonal cracks. The SE warm-up apron (feature A11B), which receives much more traffic than the NW apron, was in excellent condition, with only about 4 percent of the slabs containing major defects.

Connecting taxiways B and C

24. Both of these taxiways connecting the runway to the primary taxiway are of flexible pavement construction. The pavements were in fair condition, with random cracking in the surface (photo 2). Some longitudinal cracking occurred in taxiway C as a result of operations of aircraft during practice alerts. The taxiway was also used to park alert aircraft; and, because of the surface condition, Base Civil Engineering

personnel felt that this practice should be stopped. Therefore, at the present time, B-52 aircraft are not allowed to use this pavement.

Maintenance

25. Maintenance at MAFB has consisted of crack sealing, replacing shattered slabs, slurry sealing, joint resealing, and patching. The base annual pavement maintenance plan was obtained from the Air Force and is included as Appendix A. This maintenance plan indicates the type and amount of maintenance that has been completed through 1971. However, it was possible to obtain only the maintenance costs for the period 1 July 1971-April 1972 ($112,500). This amount was reported to be representative of the average yearly cost of maintenance performed on the airfield pavements.

26. Pop-outs are occurring in some areas of the airfield, but they have not been considered a maintenance problem. The pop-outs are small in size (3-in.-diam, maximum), and patching is not required. Sweeping keeps any loose particles resulting from pop-outs off of the pavement surfaces.

27. Problems have been experienced with some of the compounds used for joint sealing. The sealants do not adhere well to the sides of the joint and have been pulled out during sweeping operations.

Frost Action

Objectives of inspection

28. One member of the team inspected the pavement facilities for evidence of detrimental frost effects. The objectives of the inspection were to determine:

- a. Any adverse effects of frost heave to the pavements during the winter months.
- b. Any adverse effects of low-temperature contraction cracking to the flexible pavements.
- c. Any traffic-induced failures that might be related to thaw weakening of the subgrades or base courses.

Frost heave

29. The airfield pavements were inspected, traffic and nontraffic areas of flexible and rigid pavements, to identify localized or generalized surface irregularities that might indicate differential frost heaving. The inspection, which was conducted on 11 and 12 April, is believed to have coincided with or followed shortly after the period of thawing of frozen base courses and subgrades when the effects of any nonuniform heave would be most apparent.

30. Engineers in the Base Civil Engineering Office were queried regarding the development of undesirable surface unevenness during the winter, and pilots were asked to rate the degree of roughness of the runway. None of 18 pilots of B-52 and KC-135 aircraft who were canvassed rated the runway as rough (see paragraph 16). The consensus of the survey team was that the runway did not exhibit roughness detectable in an automobile at speeds of up to 60 mph.

31. The flexible pavement of the outside edges of the runway interior, which has a 72-in. combined thickness of pavement and base (as does the PCC inlay section), was quite smooth, in spite of the prevalence of low-temperature contraction cracks (see paragraph 37). The rigid inlay was 1/2 to 2 in. higher than the adjoining flexible pavement (photo 3), evidently as a consequence of greater frost heave caused by the higher reflectance of the white surface and the lower heat capacity of the thicker slabs, which allow for deeper frost penetration into the subgrade. However, vertical displacement along the longitudinal joint between the inlay and the flexible pavement is not considered by personnel at the base as an operational problem.

32. The taxiways and aprons were generally smooth at the time of the inspection. It was reported that the 1964 overlay of the primary taxiway was constructed in part to remedy a pavement roughness condition and in part to increase the load-bearing capacity. (Failures had occurred during a B-52 alert in midsummer, and an ensuing investigation disclosed lumps of clay in the base course.) While taxiways B and C had not deformed seriously, some of the crack patterns appeared to be load related.

33. In the nontraffic areas, the overruns (63-in. combined thickness of pavement and base) were found to be as smooth as the runway pavements (72-in. combined thickness of pavement and base), despite the lesser protection against subgrade freezing provided by their design thickness. Pavements on the taxiway and apron shoulders (17-in. combined thickness of pavement and base) were extremely uneven and badly cracked in many areas (photos 4 and 5). It was reported that the differential heave reaches 3 to 4 in. in these areas each year with respect to the adjacent traffic-area pavement. The most severe effects of frost heave were those observed at the concrete bases for the taxiway lights that are inserted in the shoulder pavements. While many of these inserts, particularly at the NW end of the taxiway system, were found to be flush with the shoulder pavement, many were heaved several inches above the pavement (photo 6), constituting a constant problem for snow-removal equipment. It was reported that a number of these inserts had to be removed and reconstructed so as to be flush with the surrounding pavement.

Freezing indices

34. A design freezing index of 3380 degree-days has been determined for MAFB. This value is based on temperature data from the Federal Aviation Administration Weather Station at MAFB and is the average of the three coldest winters in the past 30 years (1949-50, 1950-51, and 1968-69). The value is based on average monthly temperatures, with average daily temperatures considered for the transition months at both ends of the freezing seasons.

35. Since data are not now available to permit the determination of seasonal freezing indices at MAFB for other than the three seasons cited above, the values tabulated below are from the records of the U. S. Weather Bureau Station at Williston, North Dakota, approximately 120 miles west of Minot. Although these values do not reflect the indices actually experienced at MAFB and, being entirely determined from average monthly temperatures, are somewhat lower than indices which consider average daily temperatures for the two transition months, they do indicate the relative severity of winters since the completion of the first pavements designed for heavy-load aircraft.

Freezing Season	Freezing Index degree-days	Freezing Season	Freezing Index degree-days
1957-58	1215	1965-66	2206
1958-59	2159	1966-67	2250
1959-60	1961	1967-68	1850
1960-61	1154	1968-69	2818
1961-62	2427	1969-70	2041
1962-63	1606	1970-71	2410
1963-64	1658	1971-72	2544
1964-65	2521		
	Mean (1931-60) 2125*		

* Based on average daily temperatures.

36. Since the winter of 1968-69 is indicated to have been of design freezing index magnitude and since this condition survey closely followed a substantially colder-than-normal winter, the general absence of evidence of differential heave of the heavy-load pavements is significant. The combined thickness of pavement and base required for prevention of subgrade freezing in the design year is approximately 155 in. and for limited subgrade frost penetration is about 100 in. Accordingly, in the colder winters, substantial subgrade frost penetration can be expected under pavements with a combined thickness of 72 in. (This is the maximum thickness permitted solely for frost condition design purposes without specific approval of the Chief of Engineers.) The fact that the heave of the PCC inlay of the runway was greater than that of the adjacent AC runway edges is strong evidence that substantial subgrade freezing has indeed occurred. Yet heave resulting from such subgrade freezing has been remarkably uniform, and the condition of the rigid pavements (from very good to excellent) suggests that frost heave has not been a major cause of cracking of these pavements. (As is noted in paragraph 10, the cracking of the rigid pavements appears to be related principally to initial shrinkage during hardening of the concrete.) It is also interesting to note that the overrun pavements, with a combined thickness of pavement and base of 63 in., were as free from

distortion of the surface as a result of frost heave as were the 72-in.-thick heavy-load pavements. Frost heaving and cracking of shoulder pavements, however, have been so severe that the performance of these pavements must be termed unsatisfactory.

Low-temperature
contraction cracking

37. All of the AC pavements at MAFB have been adversely affected by low-temperature contraction cracking. This type of cracking, which is not induced by either traffic or frost heave, results from a stiffness characteristic of AC at low temperatures and its inability to withstand or adjust to thermal contraction stresses. As a general rule, contraction cracking is transverse to the center line of a facility; but, at MAFB (where the crack spacing is only about 10 to 15 ft), longitudinal cracks are nearly as prevalent as transverse cracks in some of the pavements. Photo 7 shows the primary taxiway (feature T11A) where contraction cracks are evident in the pavement of both the taxiway and the shoulder. The heavy-load flexible pavements along edges of the runway are similarly cracked. However, the cracks in the runway and taxiway pavements do not seem to have adversely affected either the load-bearing capacity or the riding quality (smoothness) of the pavement. Ravelling of the bituminous mixture at the cracks also has not been severe, as yet, but is expected to become progressively worse.

38. Of all the bituminous pavements at the base, those least affected by low-temperature contraction cracking are the runway overrun pavements, which were seal coated in 1971. They are in excellent condition, with only a few transverse cracks. Evidently, the double bituminous surface treatment is better able to adjust to contraction stresses than the hot-mix asphaltic pavement. This fact may reflect a greater tolerance of such stresses by these thin, low-stability surface courses, but more probably results from the lower temperature-susceptibility of the bitumen used in this surface treatment.

Thaw weakening

39. The extent of thaw weakening of the subgrades and base courses could not be readily determined by inspection of the pavements.

Pavement failures usually are repaired or otherwise corrected (as with overlays) as they occur and usually are not easily examined during a condition survey. However, even where examination is possible, it is often impossible to establish by visual observations whether a failure is the result of thaw weakening or of deficiencies in the thickness of the pavement components with respect to the "normal" period loading. In general, the depletion of the fatigue resistance of a pavement system in a frost area is progressive under repeated loadings and is related to thaw weakening in that the rate of depletion is greater during the frost-melting period. This rate of pavement weakening holds true whether the evidence of fatigue or failure becomes visible during the melting period or at some other time of year. Accordingly, the degree of thaw weakening and its effect, if any, on the condition of the pavements at MAFB consequently could not be appraised solely by this inspection. Some limited perception of the severity of thaw weakening effects at MAFB can be gained, however, by comparing the performance of certain pavement features with what might be expected in the light of current frost design criteria.

Pavement performance
versus frost condition criteria

40. While the combined thickness of pavement and base in the existing flexible pavements at MAFB conforms with requirements of current frost design criteria, in certain cases the AC and upper base layers are somewhat deficient in the thickness required by heavy-load design criteria. The frost capacity evaluations of the flexible pavements, which are based on the reduced subgrade strengths during the frost-melting period, are substantially less than the gross loadings corresponding to heavy-load design criteria but are only moderately less than the gross weights of the B-52 aircraft that have trafficked them (see tables 3 and 6). Taxiways B and C and features T11A and T12A of the primary taxiway may have developed some load-induced deformations during practice alerts, but the longitudinal wheel-path cracking that has ensued probably originated from deficiencies in the thickness of the surface course and upper base course rather than from inadequate

protection against thaw weakening of the subgrade. Nevertheless, the possible adverse influence of thaw weakening of subgrade materials on load-bearing capacity cannot be discounted.

41. For the existing rigid pavements, the combined thickness of pavement and base of 72 in. conforms to current frost design criteria. The PCC slab thicknesses of most of the pavement features also conform to current heavy-load design criteria, provided the modulus of reaction on the 54- to 57-in. base course actually is 450 pci as shown in previous evaluation reports. One exception is the 15-in. slab of the SAC operational apron, where current criteria would require a 16-in. slab. Frost capacity evaluations for the rigid pavements in some cases are well below the gross loadings corresponding to heavy-load design criteria but are only moderately less than the gross weights of the B-52's that have been in operation at the base. Most of the heavy-load pavements are still in very good to excellent condition, although a considerable progression of the longitudinal shrinkage cracks into structural breaks has occurred over the past decade. B-52 traffic has been considerably lighter in weight and frequency than what is assumed by the design criteria, and it may be significant that the more heavily trafficked slabs of the SAC alert taxiway and the parking areas of the SAC operational apron are in poor condition. While the general progression of longitudinal cracks that is taking place on the rigid pavements and the poor condition of the slabs noted above could have their origin in a substandard, "normal" period modulus of reaction of the base course (less than the high value of 450 pci shown in previous evaluation reports), it is also possible that the weakness is frost related. The frost capacity evaluations are based on a melting-period modulus of reaction of the base course of 315 to 335 pci, reduced values that account for the effect of subgrade weakening. The modulus of reaction would be sharply reduced below these latter values if the base courses were frost susceptible. Base materials of GW* classification (as shown in previous

* GW is a designation for a soil classification under the U. S. Department of Defense, "Unified Soil Classification System for Roads, Airfields, Embankments, and Foundations," Military Standard MIL-STD-619B, June 1968, U. S. Government Printing Office, Washington, D. C.

evaluation reports) are not usually considered frost susceptible, but even moderate thaw weakening within the base course could reduce the modulus of reaction to a level approaching critical for the loadings experienced to date.

Evaluation

42. The latest evaluation report for this airfield was prepared in 1959 (see paragraph 6b). Because some changes in gear configurations and methods of evaluation have been made since that time, a new evaluation table (table 6) has been prepared. The physical properties of the materials as determined in previous evaluations were used for this evaluation with engineering judgment applied to specific pavement areas where performance has indicated that the load-carrying capacity should be modified from that obtained in using the strength properties assigned in the reported physical property data.

Conclusions

(are among)

43. The following remarks summarize the findings of the 1972 inspection: (1)

a. The runway pavements, which are designed for 240,000-lb, twin-twin gear loads, are performing satisfactorily under present heavy-load operations; (2)

b. The interior portion of the runway is performing satisfactorily; however, there has been a substantial increase in cracking of slabs since the 1960 survey; at which time shrinkage cracking was observed to have occurred shortly after construction;

(3)

c. The pavements on the runway have experienced frost heave, as evidenced by the difference in elevation between the PCC inlay and the adjoining AC pavements. However, this heave has been uniform and has caused very little cracking in the PCC slabs; (4)

d. The flexible pavements have been adversely affected by low-temperature contraction cracking; but they appear to be smooth, and their load-bearing capacity has not been affected. (cont on p. 16)

(cont fr p 15)

e. The center lane of the SAC alert taxiway (17-in.-thick PCC) is severely distressed from B-52 operations.

f. The pavements in the SAC operational apron area (15-in.-thick PCC) are being overloaded by present operations, and distress is occurring in the pavement slabs, particularly in the area where aircraft are parked.

Table 1

Airfield Construction History

Pavement Facility	Pavement Thickness in.	Pavement Type	Design Loading lb	Construction Period
NW-SE (11-29) runway				
Ends 100-ft-wide center	16 to 18	PCC	240,000*	Apr to Oct 1957
Interior 100-ft-wide center	16	PCC	240,000*	Jul 1955 to Oct 1957
Edges of interior	4	AC	100,000**	Jul 1955 to Sep 1958
Primary taxiway				
Sta 29+90 to 109+32 and taxiways C and B	4	AC	100,000**	Jul 1955 to Nov 1956
Sta 29+90 to 109+32, 75-ft-wide overlay	1-1/2	AC		Jul 1964
Sta 29+90 to 21+40 and taxiway A	16-18-16	PCC	240,000*	Apr to Sep 1956
Sta 109+32 to 160+61	16-18-16	PCC	240,000*	Apr to Oct 1957
SAC operational apron	15 to 18	PCC	240,000*	Apr 1957 to Jul 1958
SAC hangar access apron	12	PCC	160,000*	Apr 1957 to Oct 1958
Warm-up aprons	16	PCC	240,000*	Apr to Oct 1957
ADC parking apron	16	PCC	100,000**	Jul 1955 to Sep 1956
ADC hangar access aprons and taxiway	14	PCC	80,000**	Jul 1955 to Sep 1956
ADC alert taxiway	3	AC	25,000†	Jul 1955 to Nov 1956
ADC alert apron and rear alert taxiway	10	PCC	25,000†	Jul 1955 to Jul 1956
SAC alert facility	17	PCC	265,000*	Sep 1958 to Nov 1959
ADC washrack	8	PCC	20,000†	Jul 1958 to Jun 1959
Blast pads and shoulders	2	AC		Jul 1955 to Sep 1958
Overruns (surface treatment)				Apr 1957 to Sep 1958
Power check pad	10	PCC		1963††
Missile loading facility	9	PCC	150,000**	Jun to Sep 1965
Missile loading facility access	3	AC	150,000	Jun to Sep 1965

* Twin-twin gear configuration.
** Twin gear configuration.
† Single-wheel configuration.
†† Constructed by U. S. Air Force.

Table 2

SUMMARY OF PHYSICAL PROPERTY DATA

FACILITY			OVERLAY PAVEMENT			PAVEMENT			BASE			SUBGRADE		GENERAL CONDITION OF AREA CONSIDERED
FACILITY NUMBER AND IDENTIFICATION	LENGTH FT	WIDTH FT	THICK. IN.	DESCRIPTION	FLEX. STR PSI	THICK. IN.	DESCRIPTION	FLEX. STR PSI	THICK. IN.	CLASSIFICATION	CBR OR K	CLASSIFICATION	CBR OR K	
R1A NW-SE runway Sta 19+90 to 24+90	Variable	100 to 200				18	Portland cement concrete	700	54	Gravel (GW)	450 K_r = 315	Clay (CL) Frost Group F-4		Excellent
R2B NW-SE runway Sta 19+90 to 29+90	500 to 1,000	100 to 300				16	Portland cement concrete	700	56	Gravel (GW)	450 K_r = 325	Clay (CL) Frost Group F-4		Excellent
R3C NW-SE runway interior Sta 110+90 to 141+90 NW-SE runway Sta 29+90 to 110+90 SW of ℄	3,100 8,100	100 50				16	Portland cement concrete	680	56	Gravel (GW)	450 K_r = 325	Clay (CL) Frost Group F-4		Very good
R4C NW-SE runway interior Sta 29+90 to 110+90 NE of ℄	8,100	50				16	Portland cement concrete	610	56	Gravel (GW)	450 K_r = 325	Clay (CL) Frost Group F-4		Very good
R5B NW-SE runway Sta 141+90 to 151+90	500 to 1,000	100 to 300				16	Portland cement concrete	650	56	Gravel (GW)	450 K_r = 325	Clay (CL) Frost Group F-4		Excellent
R6A NW-SE runway Sta 146+90 to 151+90	Variable	100 to 200				18	Portland cement concrete	650	54	Gravel (GW)	450 K_r = 325	Clay (CL) Frost Group F-3		Excellent
R7D NW-SE runway interior Outside edges	11,200	75				4	Asphaltic concrete		6 20 38 4	Gravel (GW) Gravel (GW) Gravel (GW) Gravel filter	100 50 40 40	Clay (CL) Frost Group F-4	10	Fair
T1A Primary taxiway NW end	5,000	75				16- 18- 16	Portland cement concrete		56 54 56	Gravel (GW)	450 K_r = 315	Clay (CL) Frost Group F-4		Very good
T2A Primary taxiway SE end	800	75				16- 18- 16	Portland cement concrete		56 54 56	Gravel (GW)	450 K_r = 315	Clay (CL) Frost Group F-4		Very good
T11A Primary taxiway Sta 60+00 to 109+32	4,932	75	1-1/2	Asphaltic concrete		4	Asphaltic concrete		6 20 38 4	Gravel (GW) Gravel (GW) Gravel (GW) Gravel filter	110 50 40 40	Clay (CL) Frost Group F-4	10	Excellent
T12A Primary taxiway Sta 30+65 to 60+00	2,935	75	1-1/2	Asphaltic concrete		4	Asphaltic concrete		6 20 38 4	Gravel (GW) Gravel (GW) Gravel (GW) Gravel filter	110 65 40 40	Clay (CL) Frost Group F-4	10	Excellent
T3A Prima[illegible] taxiway Connecting [illegible] SE end	900	75				16- 18- 16	Portland cement concrete	680	56 54 56	Gravel (GW)	450 K_r = 315	Clay (CL) Frost Group F-4		Very good
T5A SAC operational apron access taxiway T4A Apron primary taxiway extension SE	2,340 400	75 & Variable Variable				16- 18 16- 18	Portland cement [illegible]rete	650	56 54 56 54	Gravel (GW)	450 K_r = 315	Clay (CL) Frost Groups F-3 & -4		Very good
T6A T7A SAC operational access taxiway extension and NW extension	1,800	75 Variable				16- 18 18	Portland cement concrete	710	56 54 56	Gravel (GW)	450 K_r = 315	Clay (CL) Frost Groups F-3 & -4		Very good

(Continued)

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Table 2 (Continued)

SUMMARY OF PHYSICAL PROPERTY DATA

FACILITY				OVERLAY PAVEMENT			PAVEMENT			BASE			SUBGRADE		GENERAL CONDITION OF AREA CONSIDERED
FACILITY NUMBER AND IDENTIFICATION		LENGTH FT	WIDTH FT	THICK. IN.	DESCRIPTION	FLEX. STR PSI	THICK. IN.	DESCRIPTION	FLEX. STR PSI	THICK. IN.	CLASSIFICATION	CBR OR K	CLASSIFICATION	CBR OR K	
T8B	SAC hangar access taxiway	325	75				15	Portland cement concrete	670	57	Gravel (GW)	450 Kf = 335	Clay (CL) Frost Groups F-3 & -4		Fair
T9A	Taxiway A	600	75				16-18-16	Portland cement concrete	610	56 54 56	Gravel (GW)	450 Kf = 315	Clay (CL) Frost Groups F-3 & -4		Excellent
T11B	ADC rear alert taxiway	900 350±	75 Variable				10	Portland cement concrete	600	62	Gravel (GW)	450 Kf = 360	Clay (CL) Frost Group F-4		Fair
A1B A11B	NW warm-up apron SE warm-up apron	700 Variable	275 Variable				16	Portland cement concrete	680	56	Gravel (GW)	450 Kf = 325	Clay (CL) Frost Group F-4		Very good Excellent
A2B	SAC operational apron extension	1,261	600±				15	Portland cement concrete	710	57	Gravel (GW)	450 Kf = 335	Clay (CL) Frost Group F-4		Very good
A3B	SAC operational apron	1,750	600				15	Portland cement concrete	670	57	Gravel (GW)	450 Kf = 335	Clay (CL) Frost Groups F-3 & -4		Very good
A4B	SAC hangar access apron	450	425				12	Portland cement concrete	690	60	Gravel (GW)	450 Kf = 350	Clay (CL) Frost Group F-4		Poor to fair
A5B	ADC parking apron	1,001	375				16	Portland cement concrete	600	56	Gravel (GW)	450 Kf = 325	Clay (CL) Frost Groups F-3 & -4		Good
A6B	ADC hangar access aprons and taxiways	400	Variable				14	Portland cement concrete	600	58	Gravel (GW)	450 Kf = 340	Clay (CL) Frost Groups F-3 & -4		Good
A7B	ADC alert apron	300	Variable				10	Portland cement concrete	600	62	Gravel (GW)	450 Kf = 360	Clay (CL) Frost Group F-4		Fair
A8B T13B	SAC alert stubs and taxiway	4,000	150 & 75				17	Portland cement concrete	675	55	Gravel (GW)	450 Kf = 320	Clay (CL) Frost Group F-4		Stubs excellent, taxiway poor in center lane
A9B	ADC washrack and taxiway	110 370	85 50				8	Portland cement concrete	640	64	Gravel (GW)	450 Kf = 375	Clay (CL) Frost Groups F-3 & -4		Excellent
A10C	Power check pad	Irregular	Irregular				10	Portland cement concrete	650	10	Gravel (GW)	220 Kf = 60	Clay (CL)		Very good
A12B	Missile loading facility	Irregular	Irregular				9	Portland cement concrete							

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(Continued)

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Table 2 (Concluded)

SUMMARY OF PHYSICAL PROPERTY DATA

FACILITY			OVERLAY PAVEMENT			PAVEMENT			BASE			SUBGRADE		GENERAL CONDITION OF AREA CONSIDERED
FACILITY NUMBER AND IDENTIFICATION	LENGTH FT	WIDTH FT	THICK. IN.	DESCRIPTION	FLEX. STR PSI	THICK. IN.	DESCRIPTION	FLEX. STR PSI	THICK. IN.	CLASSIFICATION	CBR OR K	CLASSIFICATION	CBR OR K	
T14C Taxiway C	880	75				4	Asphaltic concrete		6 20 38 4	Gravel (GW) Gravel (GW) Gravel (GW) Gravel filter	110 65 40 40	Clay (CL) Frost Group F-3	10	Fair
T12C Taxiway B	1,540	75				4	Asphaltic concrete		6 20 38 4	Gravel (GW) Gravel (GW) Gravel (GW) Gravel filter	110 50 40 40	Clay (CL) Frost Groups F-3 & -4	10	Good
T10B ADC alert taxiway	1,420	75				3	Asphaltic concrete		6 11 48 4	Gravel (GW) Gravel (GW) Gravel (GW) Gravel filter	80 50 40 40	Clay (CL) Frost Groups F-3 & -4	10	Good

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Table 3

Aircraft Traffic Data

July 1960-December 1971

Type of Movement Involved	Type of Aircraft	No. of Operations	Average Takeoff Weight lb	Average Landing Weight lb
Takeoff starting from SE (29) end of runway; approach via SAC operational apron, SE end of primary taxiway, and SE warm-up apron	B-52	5,608	340,000-380,000	250,000
		701	420,000-450,000	250,000
Takeoff starting from SE (29) end of runway; approach via SAC alert stubs, SAC alert taxiway, and SE warm-up apron		132	340,000-380,000	250,000
		63	420,000-450,000	250,000
Takeoff starting from NW (11) end of runway; approach via SAC operational apron, NW end of primary taxiway, and NW warm-up apron		2,031	340,000-380,000	250,000
		146	420,000-450,000	250,000
Alert movement; from SAC operational apron to SE end of primary taxiway, SAC alert taxiway, SAC alert stubs, runway, NW end of primary taxiway, and back to SAC operational apron		921*	340,000-380,000	250,000
Takeoff starting from SE (29) end of runway	Tanker	4,685	225,000	140,000
	Heavy cargo	3,068	270,000	180,000
	Medium cargo	935	175,000	95,000
	All others	47,001	5,000-70,000	7,000-27,000
Takeoff starting from NW (11) end of runway	Tanker	1,617	225,000	140,000
	Heavy cargo	1,230	270,000	180,000
	Medium cargo	409	175,000	95,000
	All others	19,307	5,000-70,000	7,000-27,000

Note: Number of operations does not include touch-and-go operations. Portions of traffic data are estimated.

* Approximately 1,380 alert movements were also made by KC-135's and EC-135's using SAC operational apron, primary taxiway, and runway.

Table 4

Progression of Major Defects

Feature No.	Designation	Pavement Thickness in.	Nominal Slab Size ft	Approximate No. of Slabs	Number of Slabs by Year Containing Indicated Major Defect: Longitudinal Cracks 1960	Longitudinal Cracks 1972	Transverse Cracks 1960	Transverse Cracks 1972	Diagonal Cracks 1960	Diagonal Cracks 1972	Corner Breaks 1960	Corner Breaks 1972	Shattered Slabs 1960	Shattered Slabs 1972
R1A R2B	Runway-SE 1000 ft end	16-18	25x25	480	0	25	1	7	0	0	1	3	0	1
R3C R4C	Runway-center 100 ft inlay	16	25x25	1792	11	283	10	59	2	13	16	10	0	2
R5B R6A	Runway-NW 1000 ft end	16-18	25x25	480	2	46	1	12	1	3	3	4	0	0
A3B	SAC operational apron	15-18-15	Variable	2016	46	338	2	22	1	55	0	3	0	12
A2B	SAC operational apron extension	15-18-15	Variable	1612	7	46	4	5	1	15	0	2	0	3
T13B	SAC alert taxiway	17	Variable	438	0	63	0	14	0	7	0	6	0	44

Table 5

DATE: April 1972

SUMMARY OF DATA - RIGID PAVEMENT CONDITION SURVEY

AIRFIELD: Minot AFB, North Dakota

FEATURE NO.	FEATURE DESIGNATION	SLAB SIZE FT	APPROX NO. OF SLABS	PAVE. THICK. IN.	I	—	\	Δ	✱	K	〰	S	J	↲	J	⊕	M	P	O	C	D	% OF SLABS NO DEFECTS	% OF SLABS NO MAJOR DEFECTS	CONDITION
R1A R2B	Runway - First 500' - SE End	25x25	240	18 & 16	12	5			1		3		1	1	5		2		20	7		80	92	Excel-lent
R2B	Runway - Second 500' - SE End	25x25	240	16	13	2		3			1		6	6	7		12		18			77	90	Excel-lent
R3C R4C	Runway - Interior	25x25	1792	16	283	59	13	10	2		31		230	90	231		312		921	3		31	82	Very Good
R5B	Runway - Second 500' - NW End	25x25	240	16	15	9	2	3			6		5	2	8		*		4			48	90	Excel-lent
R5B R6B	Runway - First 500' - NW End	25x25	240	18 & 16	31	3	1	1			6				7		*		5			32	97	Excel-lent
T1A	Primary Taxiway	25x25	652	16-18-16	71	4	1				34				2		3		18	1		81	89	Very Good
T2A	Primary Taxiway	20x25 25x25	103	16-18-16	9		6		1		1		2						22			65	84	Very Good
T3A	Primary Taxiway	25x25	114	16-18-16	15	3	2				10		1						8			70	84	Very Good
T4A T5A T6A T7A	SAC Operational Apron Taxiway	25x25 22'8"x25	574	16-18-16	53	20	8	3	2		22		13	3	8				10	1		80	85	Very Good

REMARKS:

* Large percentage of slabs have light map cracking.

LEGEND:

- I LONGITUDINAL CRACK
- — TRANSVERSE CRACK
- \ DIAGONAL CRACK
- Δ CORNER BREAK
- ✱ SHATTERED SLAB
- K KEYED JOINT FAILURE
- 〰 SHRINKAGE CRACK
- S SCALING
- J SPALL ON TRANSVERSE JOINT
- ↲ SPALL ON LONGITUDINAL JOINT
- J CORNER SPALL
- ⊕ SETTLEMENT
- M MAP CRACKING
- P PUMPING JOINT
- O POP-OUT
- C UNCONTROLLED CONTRACTION CRACK
- D "D" CRACKING

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Table 5 (Continued)

DATE: April 1972

SUMMARY OF DATA - RIGID PAVEMENT CONDITION SURVEY

AIRFIELD: Minot AFB, North Dakota

FEATURE NO.	FEATURE DESIGNATION	SLAB SIZE FT	APPROX NO. OF SLABS	PAVE. THICK. IN.	NO. OF SLABS CONTAINING INDICATED DEFECTS: I	—	\	Δ	*	K	~	S	J	↓J	J	⊕	M	P	O	C	D	% OF SLABS NO DEFECTS	% OF SLABS NO MAJOR DEFECTS	CONDITION
A2B A3B	SAC Operational Apron & Extension	20x25 22'8"x25	2143**	15	384	27	55	3	12		158		5	15	8		28		8	2		72	81	Very Good
T13B	SAC Alert Taxiway	25x25 20x25	676	17	87	19	8	6	44		60		5	6	2		*		2			78	81	Very Good †
A8B	SAC Alert Stubs	20x25	711	17	18	13	11	7	4	6	16		1	6			*		2			92	93	Excel-lent
A5B	ADC Apron	25x25	650	16	116	29	7	11			7		6	90	5		73		527			22	79	Good
T9A	Taxiway A	25x25	93	16-18-16	6			1					1	1	2				48			57	92	Excel-lent
A11B	SE Warm-Up Apron	25x25	298	16	8	4	2	1			2		3	5	8		3		7			87	96	Excel-lent
A1B	NW Warm-Up Apron	25x25	209	16	14	4	6	2	2					1					3	2		85	89	Very Good

REMARKS:

* Large percentage of slabs have light map cracking.
** Total number of slabs 3004. Alert aircraft were parked on 828 slabs which were not surveyed.
† Condition of center lane rated poor.

LEGEND:

- I LONGITUDINAL CRACK
- — TRANSVERSE CRACK
- \ DIAGONAL CRACK
- Δ CORNER BREAK
- * SHATTERED SLAB
- K KEYED JOINT FAILURE
- ~ SHRINKAGE CRACK
- S SCALING
- J SPALL ON TRANSVERSE JOINT
- ↓J SPALL ON LONGITUDINAL JOINT
- J CORNER SPALL
- ⊕ SETTLEMENT
- M MAP CRACKING
- P PUMPING JOINT
- O POP-OUT
- C UNCONTROLLED CONTRACTION CRACK
- D "D" CRACKING

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Table 6

SUMMARY OF PAVEMENT EVALUATION

NAME OF AIRFIELD: Minot

DATE OF EVALUATION
MONTH: April YR: 1972

FEATURE		PAVEMENT OPERATIONAL USE	LOAD-CARRYING CAPACITY IN LB OF GROSS PLANE LOAD FOR INDICATED LANDING GEAR TYPES AND CONFIGURATIONS										REMARKS
			TRICYCLE ARRANGEMENT									BICYCLE	
NO.	DESIGNATION		SINGLE 100-PSI TIRE PRESSURE	SINGLE 100-SQ-IN. CONTACT AREA	SINGLE 241-SQ-IN. CONTACT AREA	TW 28-IN. C-C 226-SQ-IN. CONTACT AREA EACH TIRE	SINGLE TANDEM 60-IN. SPACING 400-SQ-IN. CONTACT AREA	TW 37-IN. C-C 267-SQ-IN. CONTACT AREA EACH TIRE	TW 44-IN. C-C 630-SQ-IN. CONTACT AREA EACH TIRE	TWIN TANDEM 33 IN. × 48 IN. 208-SQ-IN. CONTACT AREA EACH TIRE	C-5A GEAR CONFIGURATION	TWIN TWIN SPCG 37-62-37 267-SQ-IN. CONTACT AREA EACH TIRE	
			1	2	3	4	5	6	7	8	9	10	
R1A	NW-SE runway	Capacity	155,000+	65,000+	155,000+	220,000+	200,000+	330,000+	300,000+	380,000+	800,000+	590,000	
	Sta 19+90 to 24+90	Frost Capacity	155,000+	65,000+	155,000+	220,000+	200,000+	310,000	300,000+	380,000+	800,000+	470,000	
R2B	NW-SE runway	Capacity	155,000+	65,000+	155,000+	220,000+	200,000+	330,000+	300,000+	380,000+	800,000+	540,000	
	Sta 19+90 to 29+90	Frost Capacity	155,000+	65,000+	155,000+	220,000+	200,000+	300,000	300,000+	380,000+	800,000+	420,000	
R3C	NW-SE runway	Capacity	155,000+	65,000+	155,000+	220,000+	200,000+	330,000+	300,000+	380,000+	800,000+	600,000+	
	Sta 110+90 to 141+90 Sta 29+90 to 110+90 SW of ℄	Frost Capacity	155,000+	65,000+	155,000+	220,000+	200,000+	330,000+	300,000+	380,000+	800,000+	550,000	
R4C	NW-SE runway	Capacity	155,000+	65,000+	155,000+	220,000+	200,000+	330,000+	300,000+	380,000+	800,000+	600,000+	
	Sta 29+90 to 110+90 NE of ℄	Frost Capacity	155,000+	65,000+	155,000+	220,000+	200,000+	330,000+	300,000+	380,000+	800,000+	490,000	
R5B	NW-SE runway	Capacity	155,000+	65,000+	155,000+	220,000+	200,000+	330,000+	300,000+	380,000+	800,000+	500,000	
	Sta 141+90 to 151+90	Frost Capacity	155,000+	65,000+	155,000+	220,000+	200,000+	285,000	300,000+	380,000+	800,000+	390,000	
R6A	NW-SE runway	Capacity	155,000+	65,000+	155,000+	220,000+	200,000+	330,000+	300,000+	380,000+	800,000+	560,000	
	Sta 146+90 to 151+90	Frost Capacity	155,000+	65,000+	155,000+	220,000+	200,000+	290,000	300,000+	380,000+	800,000+	440,000	
T1A	Primary taxiway-NW end	Capacity	155,000+	65,000+	155,000+	220,000+	200,000+	330,000+	300,000+	380,000+	800,000+	540,000	
		Frost capacity	155,000+	65,000+	155,000+	220,000+	200,000+	295,000	300,000+	380,000+	800,000+	450,000	
T2A	Primary taxiway-SE end	Capacity	155,000+	65,000+	155,000+	220,000+	200,000+	330,000+	300,000+	380,000+	800,000+	530,000	
		Frost capacity	155,000+	65,000+	155,000+	220,000+	200,000+	265,000	300,000+	380,000+	800,000+	400,000	

Note: + sign denotes allowable gross loading greater than maximum gross weight of any existing aircraft having indicated gear configuration.
(a) denotes allowable gross loading less than minimum gross weight of any existing aircraft having indicated gear configuration.

WES FORM NO. 999 JUNE 1972 EDITION OF AUG 1960 IS OBSOLETE.

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Table 6 (Continued)

SUMMARY OF PAVEMENT EVALUATION

NAME OF AIRFIELD: Minot

DATE OF EVALUATION MONTH: April YR: 1972

FEATURE NO.	FEATURE DESIGNATION	PAVEMENT OPERATIONAL USE	Tricycle: SINGLE 100-PSI TIRE PRESSURE (1)	Tricycle: SINGLE 100-SQ-IN. CONTACT AREA (2)	Tricycle: SINGLE 241-SQ-IN. CONTACT AREA (3)	Tricycle: TW 28-IN. C-C 226-SQ-IN. CONTACT AREA EACH TIRE (4)	Tricycle: SINGLE TANDEM 60-IN. SPACING 400-SQ-IN. CONTACT AREA (5)	Tricycle: TW 37-IN. C-C 267-SQ-IN. CONTACT AREA EACH TIRE (6)	Tricycle: TW 44-IN. C-C 630-SQ-IN. CONTACT AREA EACH TIRE (7)	Tricycle: TWIN TANDEM 33 IN. × 48 IN. 208-SQ-IN. CONTACT AREA EACH TIRE (8)	Tricycle: C-5A GEAR CONFIGURATION (9)	Bicycle: TWIN TWIN SPCG 37-62-37 267-SQ-IN. CONTACT AREA EACH TIRE (10)	REMARKS
T3A	Primary taxiway-connecting SE end	Capacity	155,000+	65,000+	155,000+	220,000+	200,000+	330,000+	300,000+	380,000+	800,000+	580,000	
		Frost capacity	155,000+	65,000+	155,000+	220,000+	200,000+	300,000	300,000+	380,000+	800,000+	450,000	
T5A	SAC operational apron access taxiway-SE extension	Capacity	155,000+	65,000+	155,000+	220,000+	200,000+	330,000+	300,000+	380,000+	800,000+	570,000	
		Frost capacity	155,000+	65,000+	155,000+	220,000+	200,000+	300,000	300,000+	380,000+	800,000+	450,000	
T7A	SAC operational apron access taxiway-NW extension	Capacity	155,000+	65,000+	155,000+	220,000+	200,000+	330,000+	300,000+	380,000+	800,000+	600,000+	
		Frost capacity	155,000+	65,000+	155,000+	220,000+	200,000+	310,000	300,000+	380,000+	800,000+	480,000	
T8B	SAC hangar access taxiway	Capacity	155,000+	65,000+	155,000+	220,000+	200,000+	330,000+	300,000+	380,000+	800,000+	470,000	
		Frost capacity	155,000+	65,000+	155,000+	220,000+	200,000+	265,000	300,000+	380,000+	800,000+	370,000	
T9A	Taxiway A	Capacity	155,000+	65,000+	155,000+	220,000+	200,000+	310,000	300,000+	380,000+	800,000+	480,000	
		Frost capacity	155,000+	65,000+	155,000+	220,000+	200,000+	265,000	300,000+	380,000+	800,000+	400,000	
T10B	ADC alert taxiway	Capacity	150,000	60,000	90,000	105,000	160,000	205,000	200,000	265,000	720,000	290,000	
		Frost capacity	150,000	60,000	90,000	105,000	160,000	205,000	200,000	265,000	720,000	290,000	
A1B & A11B	NW warm-up apron & SE warm-up apron	Capacity	155,000+	65,000+	155,000+	220,000+	200,000+	330,000+	300,000+	380,000+	800,000+	530,000	
		Frost capacity	155,000+	65,000+	155,000+	220,000+	200,000+	295,000	300,000+	380,000+	800,000+	410,000	
A2B	SAC operational apron ext	Capacity	155,000+	65,000+	155,000+	220,000+	200,000+	330,000+	300,000+	380,000+	800,000+	540,000	
		Frost capacity	155,000+	65,000+	155,000+	220,000+	200,000+	300,000	300,000+	380,000+	800,000+	410,000	
A3B	SAC operational apron	Capacity	155,000+	65,000+	155,000+	220,000+	200,000+	330,000+	300,000+	380,000+	800,000+	470,000	
		Frost capacity	155,000+	65,000+	155,000+	220,000+	200,000+	265,000	300,000+	380,000+	800,000+	370,000	
A4B	SAC hangar access apron	Capacity	140,000	65,000+	155,000+	210,000	200,000+	240,000	300,000+	380,000+	800,000+	350,000	
		Frost capacity	120,000	65,000+	155,000+	180,000	200,000+	205,000	300,000+	380,000+	800,000+	295,000	
A5B	ADC parking apron	Capacity	155,000+	65,000+	155,000+	220,000+	200,000+	320,000	300,000+	380,000+	800,000+	450,000	
		Frost capacity	155,000+	65,000+	155,000+	220,000+	200,000+	265,000	300,000+	380,000+	800,000+	370,000	

WES FORM NO. 999 JUNE 1972 EDITION OF AUG 1960 IS OBSOLETE.

(2 of 3 sheets)

Table 6 (Continued)

SUMMARY OF PAVEMENT EVALUATION

NAME OF AIRFIELD: Minot

DATE OF EVALUATION MONTH: April YR: 1972

			LOAD-CARRYING CAPACITY IN LB OF GROSS PLANE LOAD FOR INDICATED LANDING GEAR TYPES AND CONFIGURATIONS										
			TRICYCLE ARRANGEMENT									BICYCLE	
FEATURE		PAVEMENT OPERATIONAL USE	SINGLE 100-PSI TIRE PRESSURE	SINGLE 100-SQ-IN. CONTACT AREA	SINGLE 241-SQ-IN. CONTACT AREA	TW 28-IN. C-C 226-SQ-IN. CONTACT AREA EACH TIRE	SINGLE TANDEM 60-IN. SPACING 400-SQ-IN. CONTACT AREA	TW 37-IN. C-C 267-SQ-IN. CONTACT AREA EACH TIRE	TW 44-IN. C-C 630-SQ-IN. CONTACT AREA EACH TIRE	TWIN TANDEM 33 IN. × 48 IN. 208-SQ-IN. CONTACT AREA EACH TIRE	C-5A GEAR CONFIGURATION	TWIN TWIN SPCG 37-62-37 267-SQ-IN. CONTACT AREA EACH TIRE	REMARKS
NO.	DESIGNATION		1	2	3	4	5	6	7	8	9	10	
A6B	ADC hangar access aprons & taxiways	Capacity	155,000+	65,000+	155,000+	220,000+	200,000+	270,000	300,000+	380,000+	800,000+	380,000	
		Frost capacity	135,000	65,000+	155,000+	195,000	200,000+	225,000	300,000+	380,000+	800,000+	310,000	
A7B	ADC alert apron	Capacity	90,000	65,000+	140,000	140,000	200,000+	160,000	230,000	310,000	800,000+	230,000	
		Frost capacity	75,000	60,000	120,000	120,000	190,000	135,000	190,000	260,000	700,000	(a)	
A8B & T13B	SAC alert stubs & taxiway	Capacity	155,000+	65,000+	155,000+	220,000+	200,000+	330,000+	300,000+	380,000+	800,000+	570,000	
		Frost capacity	155,000+	65,000+	155,000+	220,000+	200,000+	330,000	300,000+	380,000+	800,000+	450,000	
A9B	ADC wash rack & taxiway	Capacity	70,000	50,000	120,000	110,000	175,000	130,000	190,000	245,000	680,000	(a)	
		Frost capacity	60,000	45,000	95,000	95,000	150,000	110,000	160,000	205,000	560,000	(a)	
A10C	Power Check Pad	Capacity	90,000	65,000+	90,000	140,000	200,000+	160,000	225,000	310,000	800,000+	230,000	
		Frost capacity	75,000	60,000	70,000	120,000	200,000+	140,000	200,000	275,000	740,000	(a)	
T11A	Primary taxiway Sta 29+90 to 60+00	Capacity	155,000+	65,000+	140,000	180,000	200,000+	240,000	300,000	360,000	800,000+	400,000	
		Frost capacity	155,000+	65,000+	140,000	180,000	200,000+	240,000	300,000	345,000	800,000+	350,000	
T12A	Primary taxiway Sta 60+00 to 109+32	Capacity	155,000+	65,000+	140,000	180,000	200,000+	240,000	300,000	360,000	800,000+	420,000	
		Frost capacity	155,000+	65,000+	140,000	180,000	200,000+	240,000	300,000	345,000	800,000+	350,000	
T12C	Taxiway B	Capacity	155,000+	65,000+	155,000+	220,000+	200,000+	330,000+	300,000+	380,000+	800,000+	580,000	
		Frost capacity	155,000+	65,000+	155,000+	220,000+	200,000+	330,000+	300,000+	380,000+	800,000+	470,000	
T14C	Taxiway C	Capacity	155,000+	65,000+	155,000+	220,000+	200,000+	330,000+	300,000+	380,000+	800,000+	600,000+	
		Frost capacity	155,000+	65,000+	155,000+	220,000+	200,000+	330,000+	300,000+	380,000+	800,000+	470,000	

WES FORM NO. 999 JUNE 1972 EDITION OF AUG 1960 IS OBSOLETE.

(3 of 3 sheets)

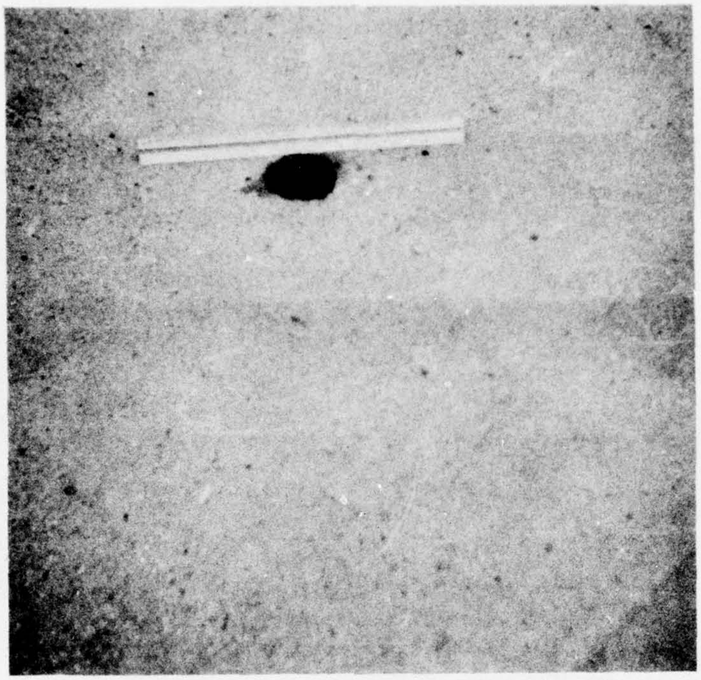


Photo 1. Pop-out in runway interior (approximately maximum size observed)

Photo 2. Random cracking in taxiway C

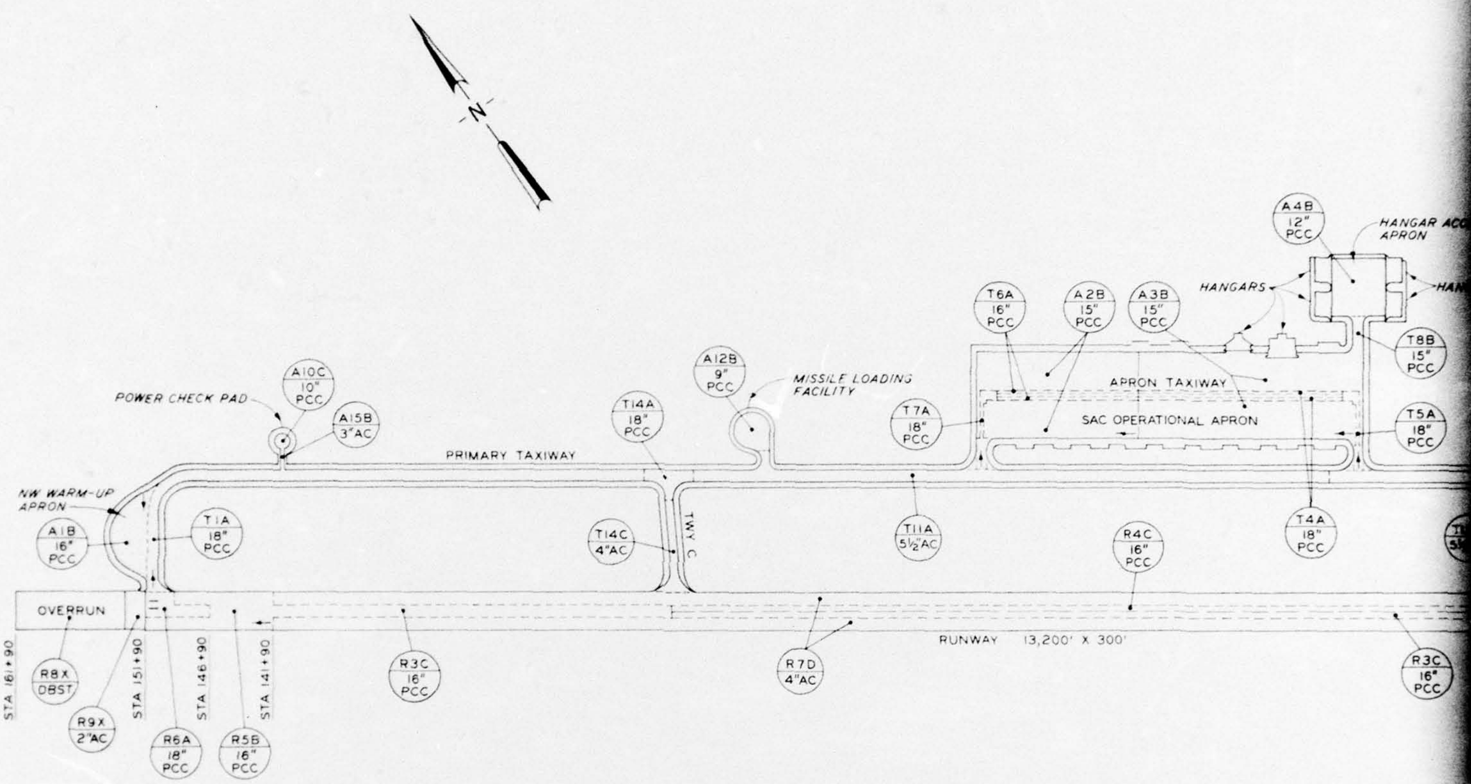
Photo 3. PCC runway keel heaved 2 in. above AC runway edge pavement near intersection of runway with taxiway C

Photo 4. Random cracking of shoulder pavement at taxiway B caused by nonuniform frost heave

Photo 5. Shoulder pavement of parallel taxiway heaved 1-1/2 in. above edge of feature T11A

Photo 6. Differential frost heave at concrete insert in shoulder of taxiway B

Photo 7. Transverse and longitudinal low-temperature contraction cracks at spacing of 10 to 15 ft in edge of primary taxiway (feature T11A)



SCALE IN FEET

500 0 500 1000 1500

LEGEND

R2X ← FEATURE DESIGNATION (SEE NOTE 1)
2"AC ← SURFACE PAVEMENT THICKNESS AND TYPE

TYPE OF FEATURE

- R – RUNWAY
- T – TAXIWAY
- A – APRON

TYPE TRAFFIC AREA (SEE NOTE 2)

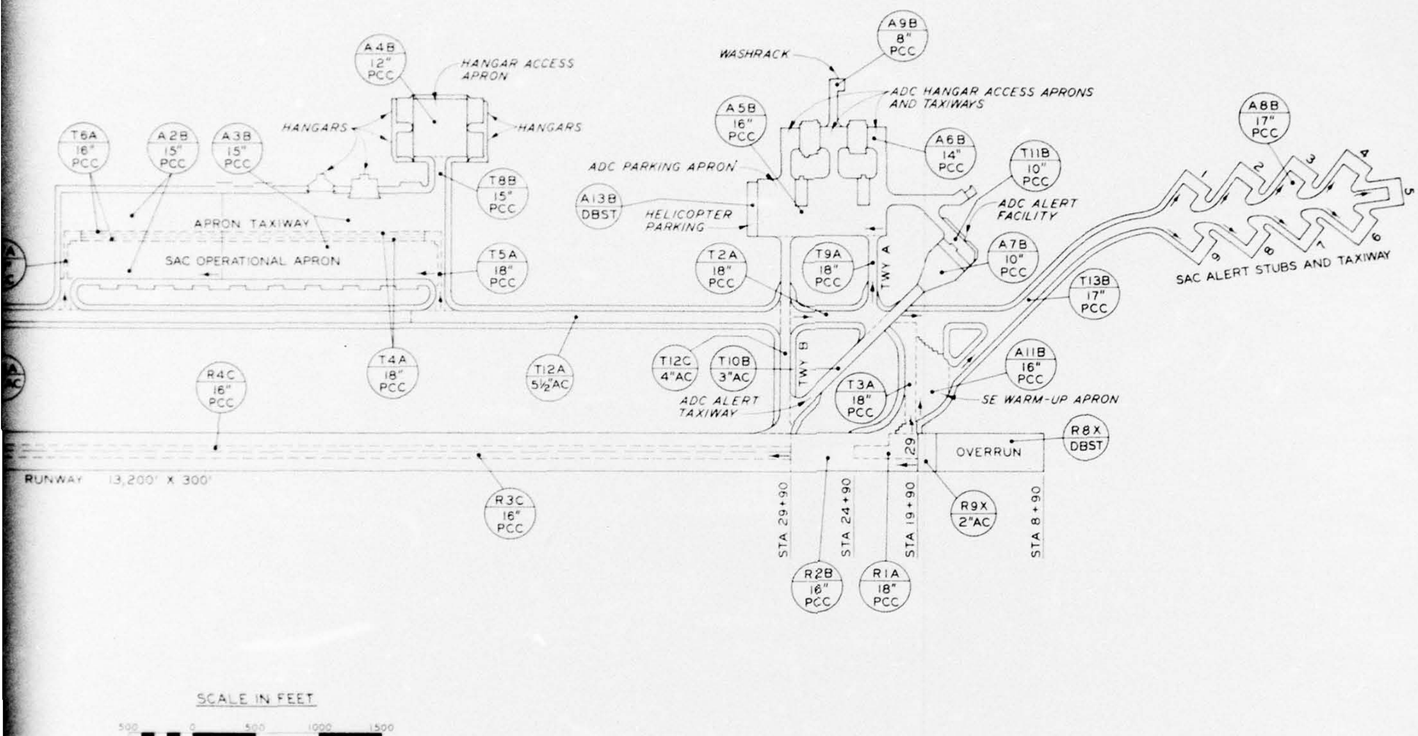
- A – A TYPE TRAFFIC
- B – B TYPE TRAFFIC
- C – C TYPE TRAFFIC
- D – D TYPE TRAFFIC
- X – NO TRAFFIC TYPE ASSIGNED

AC – ASPHALTIC CONCRETE
PCC – PORTLAND CEMENT CONCRETE
DBST – DOUBLE BITUMINOUS SURFACE TREATMENT
→ – DIRECTION OF SURVEY

NOTES: 1. FEATURE DESIGNATION DENOTES TYPE OF FEATURE, NUMBER OF FEATURE FOR GIVEN TYPE, AND TYPE TRAFFIC AREA.

2. TRAFFIC AREA DESIGNATIONS ARE BASED ON HEAVY-LOAD CRITERIA.

1



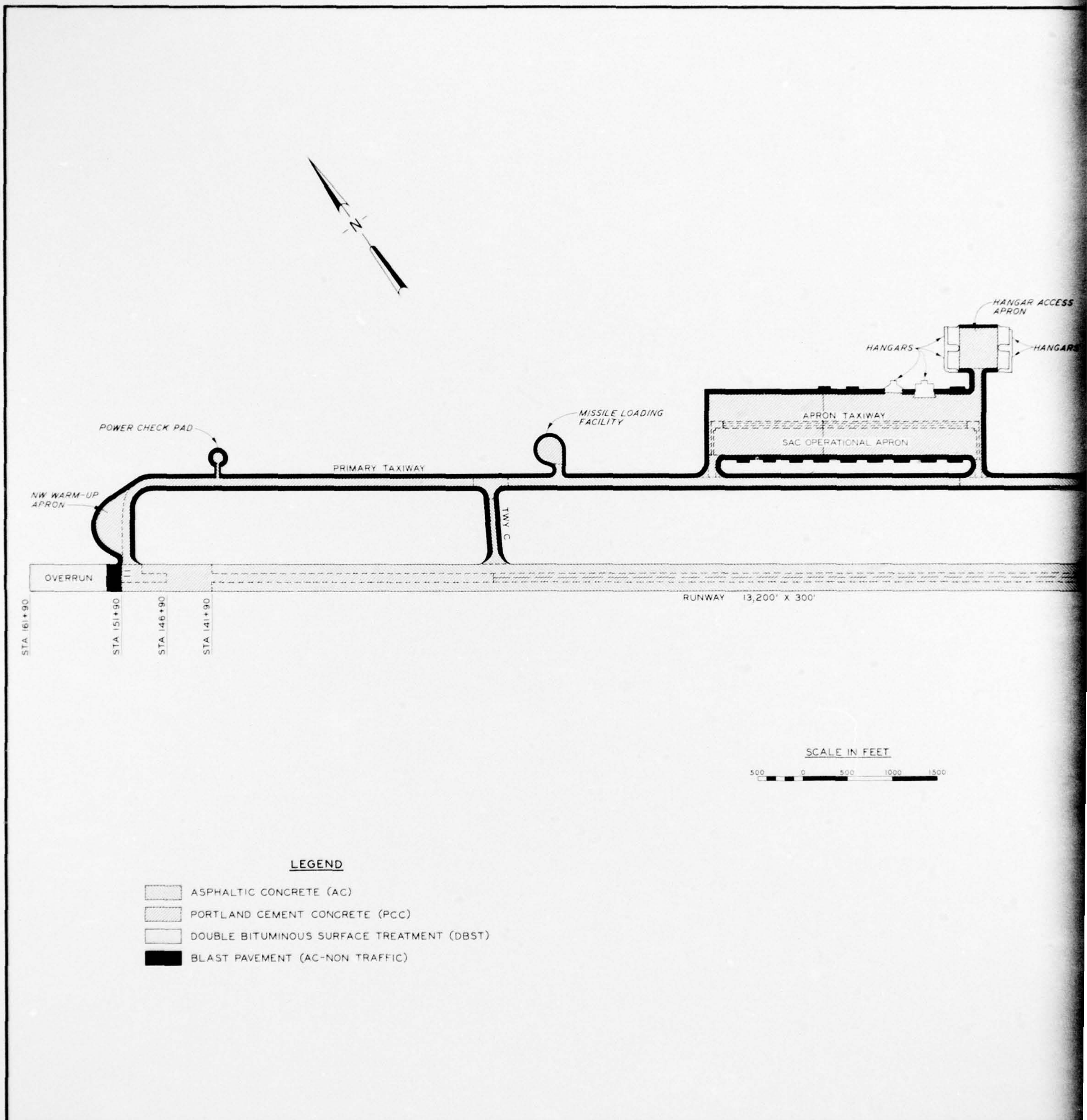
NOTES: 1. FEATURE DESIGNATION DENOTES TYPE OF FEATURE, NUMBER OF FEATURE FOR GIVEN TYPE, AND TYPE TRAFFIC AREA.

2. TRAFFIC AREA DESIGNATIONS ARE BASED ON HEAVY-LOAD CRITERIA.

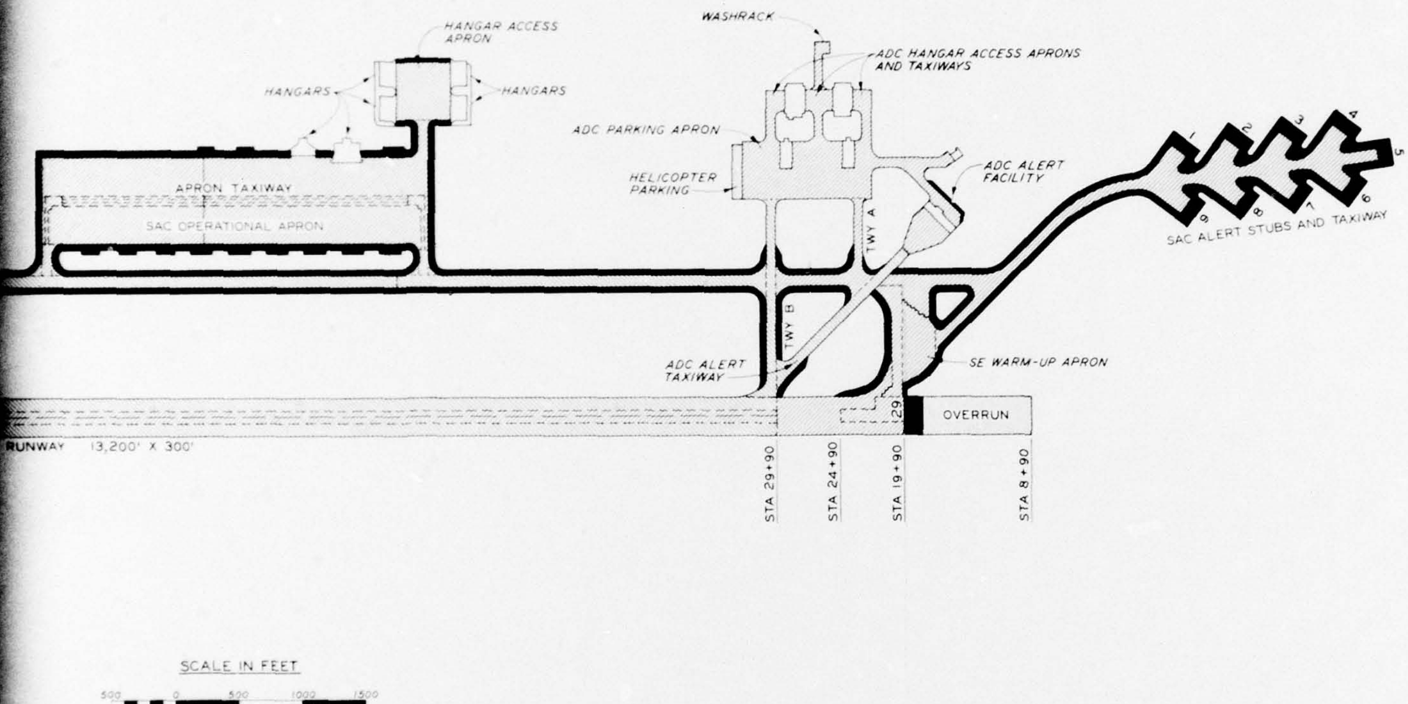
MINOT AIR FORCE BASE
NORTH DAKOTA

AIRFIELD LAYOUT

PLATE 1



N
HANGAR ACCESS APRON
HANGARS
HANGARS
MISSILE LOADING FACILITY
POWER CHECK PAD
APRON TAXIWAY
SAC OPERATIONAL APRON
PRIMARY TAXIWAY
NW WARM-UP APRON
TWY C
OVERRUN
RUNWAY 13,200' X 300'
STA 161+90
STA 151+90
STA 146+90
STA 141+90
SCALE IN FEET
500
0
500
1000
1500
LEGEND
ASPHALTIC CONCRETE (AC)
PORTLAND CEMENT CONCRETE (PCC)
DOUBLE BITUMINOUS SURFACE TREATMENT (DBST)
BLAST PAVEMENT (AC-NON TRAFFIC)



MINOT AIR FORCE BASE
NORTH DAKOTA

PAVEMENT PLAN

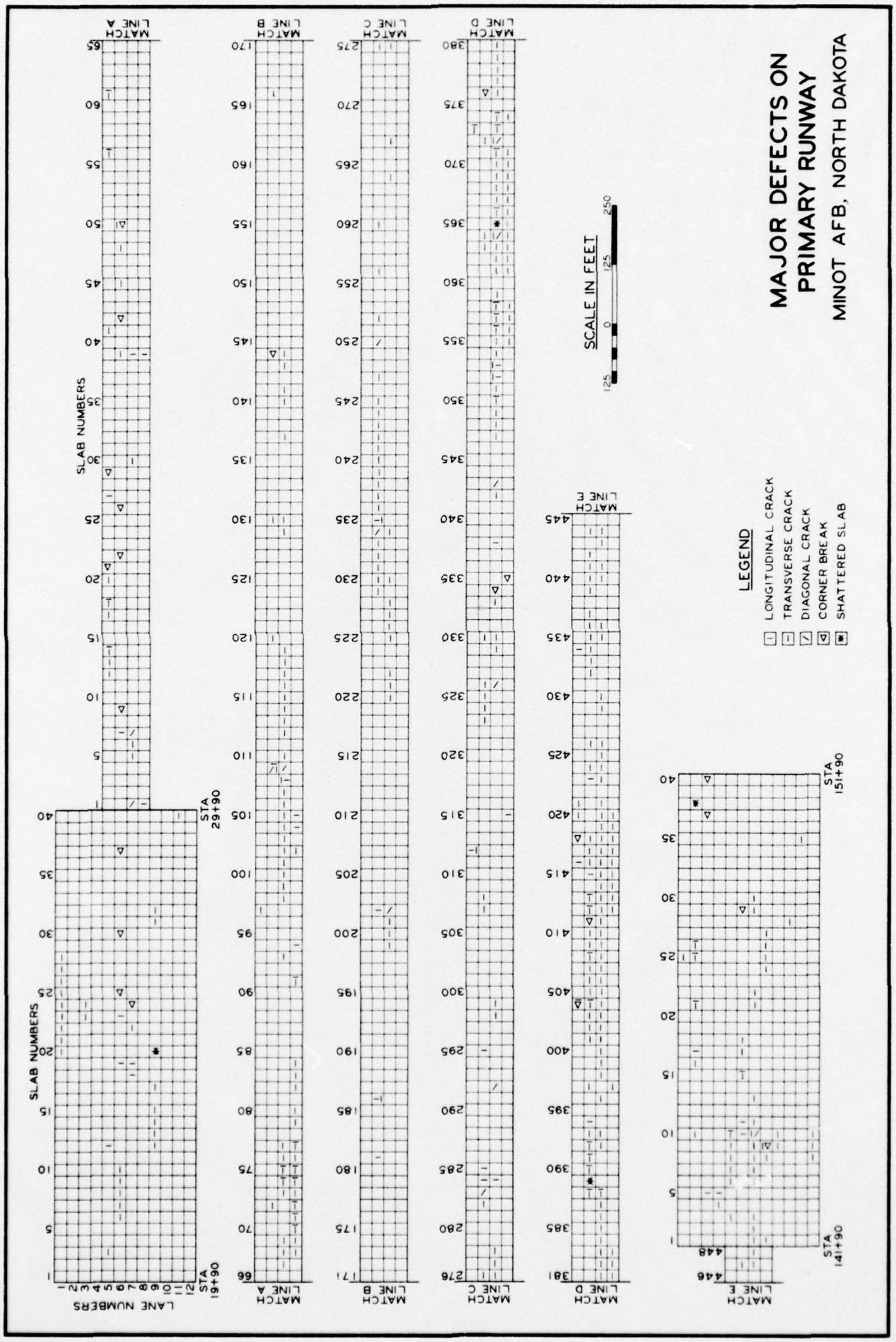
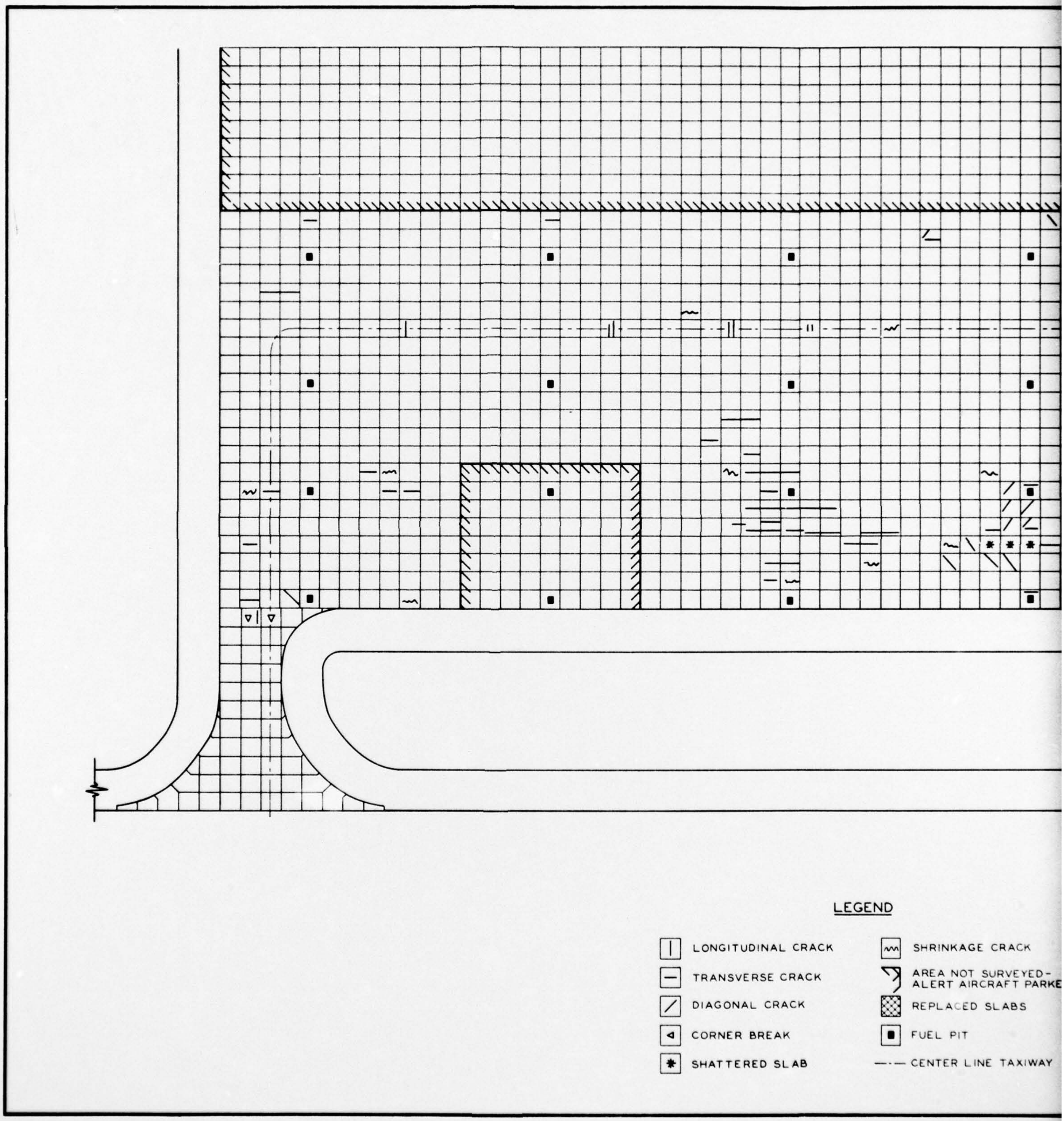
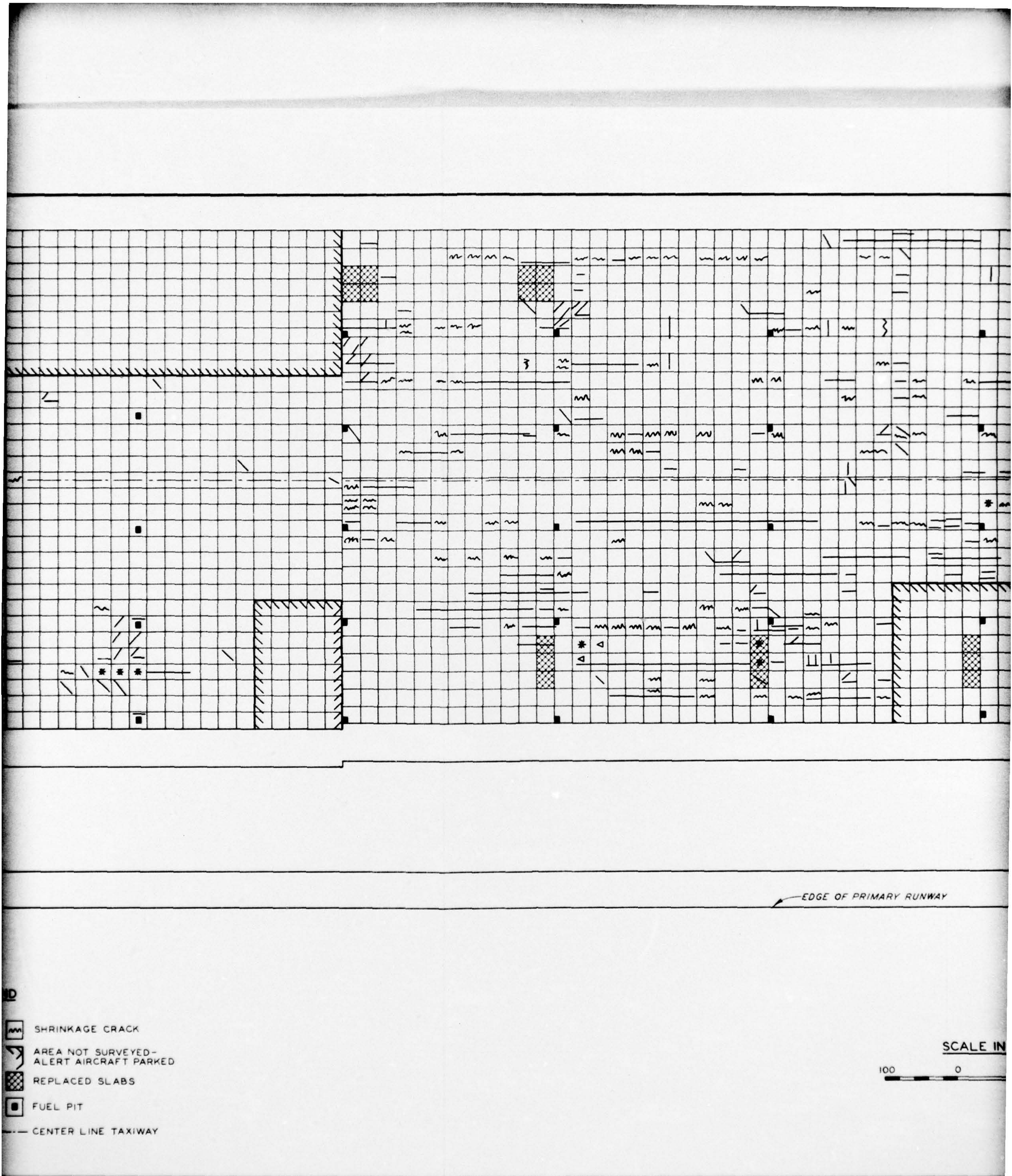

MAJOR DEFECTS ON
PRIMARY RUNWAY
MINOT AFB, NORTH DAKOTA
LEGEND
LONGITUDINAL CRACK
TRANSVERSE CRACK
DIAGONAL CRACK
CORNER BREAK
SHATTERED SLAB
SCALE IN FEET
125
0
125
250
SLAB NUMBERS
LANE NUMBERS
STA 19+90
STA 29+90
STA 141+90
STA 151+90
MATCH LINE A
MATCH LINE B
MATCH LINE C
MATCH LINE D
MATCH LINE E

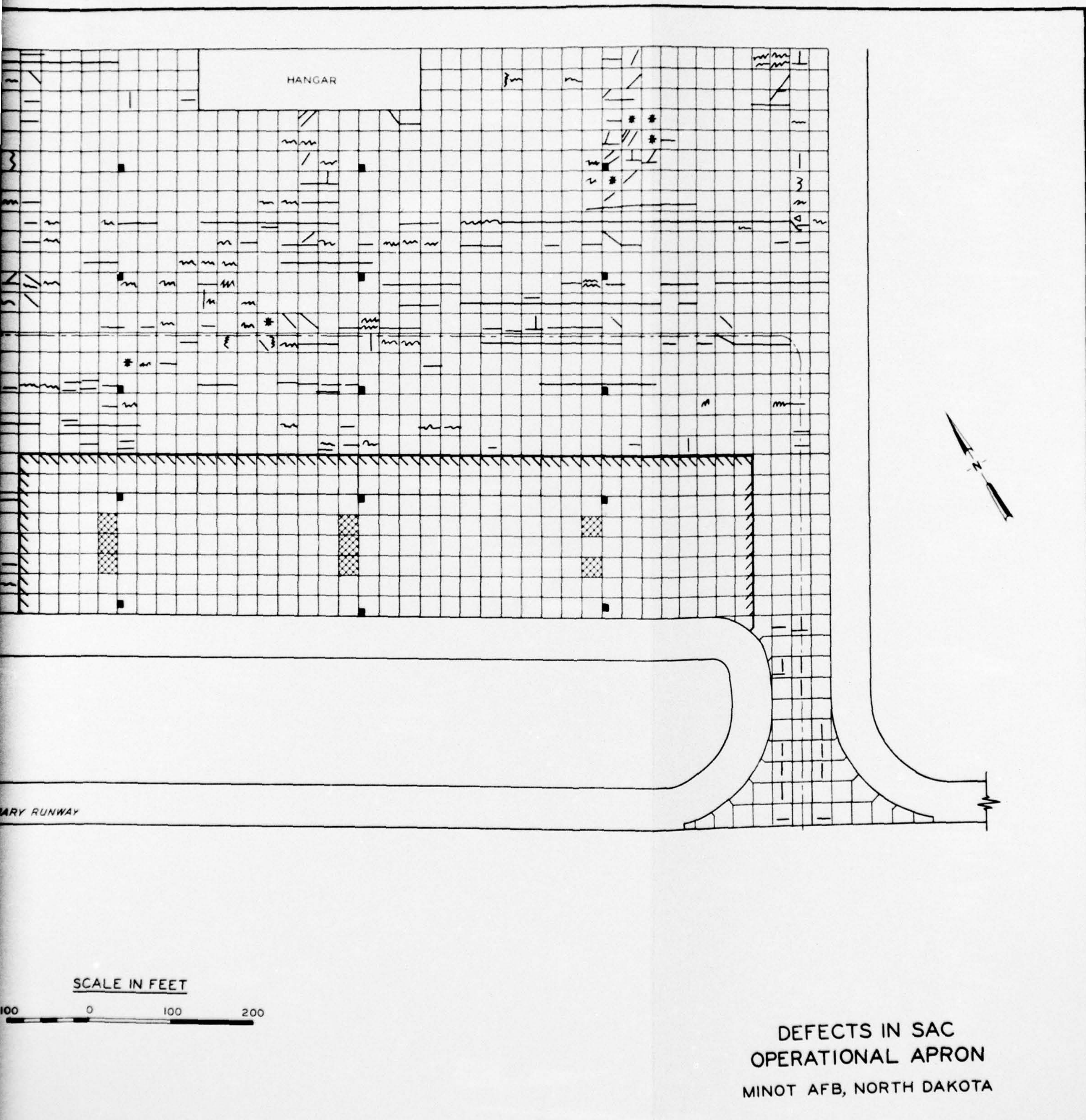
PLATE 3



LEGEND
LONGITUDINAL CRACK
TRANSVERSE CRACK
DIAGONAL CRACK
CORNER BREAK
SHATTERED SLAB
SHRINKAGE CRACK
AREA NOT SURVEYED-
ALERT AIRCRAFT PARKE
REPLACED SLABS
FUEL PIT
CENTER LINE TAXIWAY


EDGE OF PRIMARY RUNWAY
ND
SHRINKAGE CRACK
AREA NOT SURVEYED-
ALERT AIRCRAFT PARKED
REPLACED SLABS
FUEL PIT
CENTER LINE TAXIWAY
SCALE IN
100
0

2



DEFECTS IN SAC
OPERATIONAL APRON
MINOT AFB, NORTH DAKOTA

PLATE 4

3

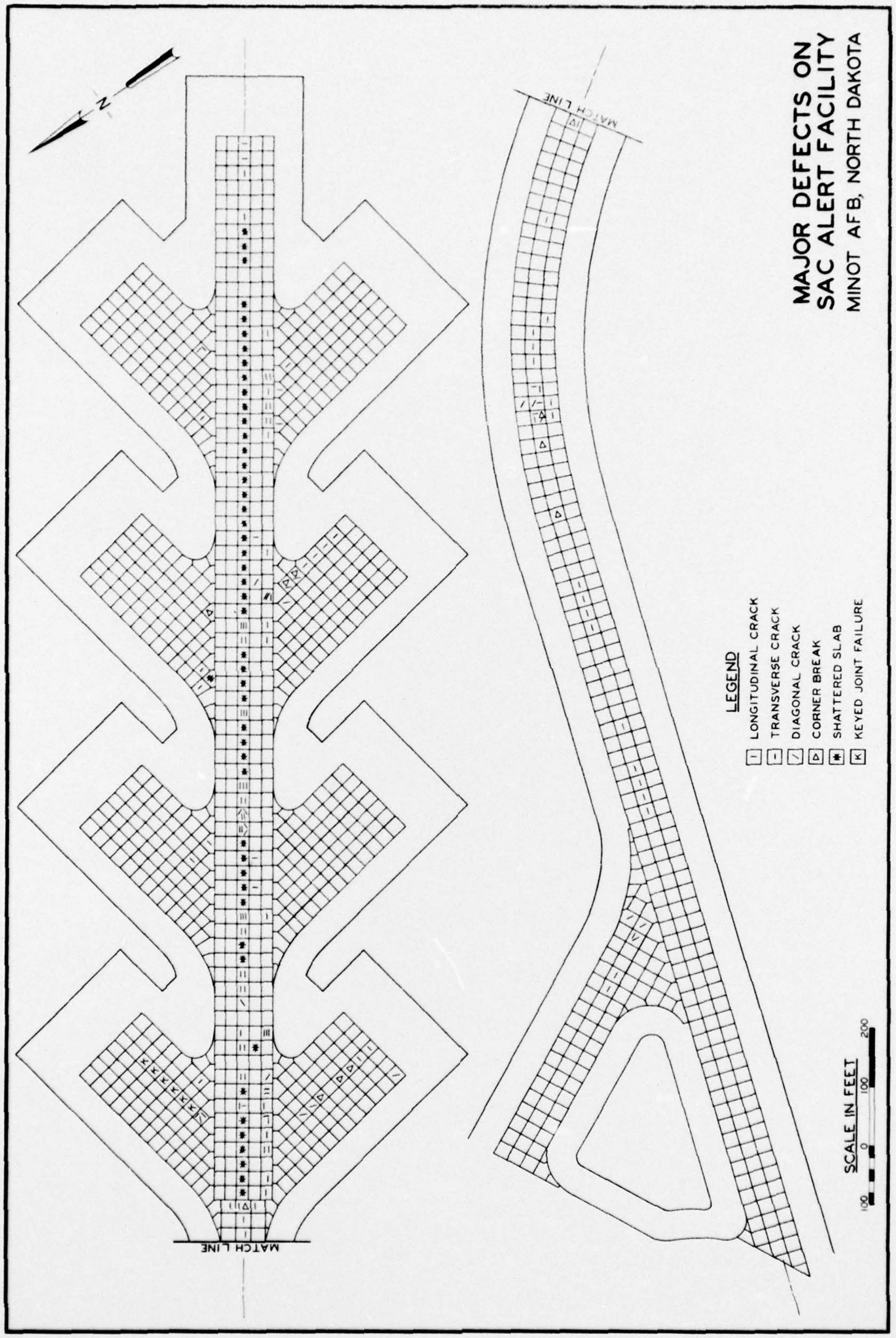

MAJOR DEFECTS ON
SAC ALERT FACILITY
MINOT AFB, NORTH DAKOTA
LEGEND
LONGITUDINAL CRACK
TRANSVERSE CRACK
DIAGONAL CRACK
CORNER BREAK
SHATTERED SLAB
KEYED JOINT FAILURE
SCALE IN FEET
100 0 100 200
MATCH LINE
MATCH LINE
N

PLATE 5

Appendix A: MAFB Annual Pavement Maintenance Plan

No.	Description	Pavement Type	Yr Const	Maint & Repair History	Present or Proposed Maint and Repair
1.	Primary R/W All wea. Inst. 11,200' x 100' Fac. No. 1917	Rigid - Heavy 16" - 18"	1957	a. Seal cracks & joints, popout repair & Markings, MIN 437-1, 1962. b. Paint markings. MIN 207-4, 1965 c. Jt Seal MIN 7-6, 1965. d. Sand Seal MIN 3-6, 1965 e. MIN 956-6 - Joint Seal, Oct 1966 f. MIN 21-8 Joint Seal, Sep 68	*None MIN 13-2 Joint Seal FY72
2.	Overruns 2 x 850' x 300' 2 x 150' x 300' Fac. No. 1918	Non-Traffic Dbl. Bit. Trmt. Flexi - 2" A.C.	1957	a. Paint Markings, MIN 160-3, Jun 1967 b. Crack Seal, MC-250, May-June 1967 I.H. c. Crack Seal, MC-250, May-June 1968 I.H. d. Crack Seal, MC-250, May-June 1969 I.H.	*None MIN 75-2 Chip Seal FY72 MIN 3-6 Chip Seal FY76
3.	ADC Alert T/W 1800' x 75' Fac. No. 1924	Flex - Light 3"	1956	a. Slurry seal, paint markings, MIN 437-1, 1962 b. Paint markings, MIN 4-5, Nov 1964 c. Same as 1c	*None
4.	Alert Hangar Access Apron 75' x 900' Fac. No. 1924	Rigid - Light 10"	1956	a. Seal cracks and joints MIN 016-3, 1961 b. MIN 7-5, Paint markings, Nov, 1964	*None
5.	ADC Parking Apron 450' x 1001' Fac. No. 1934 & 1935	Rigid - Heavy 16"	1956	a. Same as four a. b. MIN 9-5 - Paint markings, Nov, 1964	*None
6.	ADC Hangar Access Apron & T-W 3 x 75' x 230 830' x 175 Fac. No. 1932 & 1933	Rigid - Light 14"	1956	a. MIN 18-5 - Paint, Nov 1964 b. MIN 157-3, 158-3 and 159-3, Joint seal, Aug 1963	*None
	Washrack & Access 290' x 50' 110' x 80' Fac. No. 1940	8"			

(Continued)

* Normal Routine Maintenance as required by Base Forces and AFLC Stripper.

Appendix A (Continued)

No.	Description	Pavement Type	Yr Const	Maint & Repair History	Present or Proposed Maint and Repair
7.	SAC Operations Apron 679'-4" x 1261' 675' x 1750' Fac. No. 1936	Rigid - Heavy 15" - 16" - 18"	1958	a. Same as 6b b. Sand seal MIN 3-6, 1965 c. Paint - 2AF strip, 1965 d. Repl 15 PCC slabs, 1965 e. MIN 100-0, Repl Slabs, Aug 70	*None
8.	SAC Alert Apron and T/W 245 x 150' 119.5 x 119.5/2 100' x 1817' 75' x 2931' Fac. No. 1937	Rigid - Heavy 17"	1959	a. Same as 1c b. Jt Seal MIN 8-6, 1965 c. Same as 1b	*None
9.	T/W C 880' x 75' Fac. No. 1919	Flex - Heavy 4"	1956	a. Same as 1b, 1c, 7c b. Paint MIN 8-5, Nov 1964	*None
10.	T/W B 1550' x 75' Fac. No. 1919	Flex - Heavy 4"	1956	a. Same as 1c, 3a, 7c and 9b b. Jt Seal MIN 9-6, 1965	*None
11.	Warm up Apron, West 880' x 380' Fac. No. 1938	Rigid - Heavy 16"	1957	a. MIN 5-5, Paint 1964 b. Jt Seal MIN 9-6, 1965 c. Same as 7b and 7c	*None
12.	Primary T/W exten- sion, West Sta 109 + 32 to 160 + 61 75' x 5189' Fac. No. 1929	Rigid - Heavy 16" - 18"	1957	a. MIN 5-5, Paint, 1964 b. Same as 9a, 9b, 7c and 1c c. Jt Seal MIN 10-6, 1965	*None
13.	Warm up Apron, East 880' x 380' Fac. No. 1938	Rigid - Heavy 16"	1957	a. Same as 1c, 7c and 11a	*None
14.	Primary T/W, East Sta 29+90-109+32 75' x 7942' Fac. No. 1919	Flex - Heavy 4" + 1-1/2 OL	1956	a. Same as 3a, 3b and 7c b. MIN 227-4 1-1/2" AC Overlay, Oct 64. c. Sand Seal MIN 10-6, 1965	*None

(Continued)

No.	Description	Pavement Type	Yr Const	Maint & Repair History	Present or Proposed Maint and Repair
15.	SAC Apron Hangar Access, 425' x 450' Fac. No. 1921	Rigid - Heavy 12"	1958	a. Same as 6(b), 7b and 7c	*None
16.	Prim T/W Extension SE, 75' x 500' Fac. No. 1929	Rigid - Heavy 16" - 18"	1957	a. Same as (1) except no painting and 9a b. Same as 1c and 7c c. MIN 22-8, Replace Slabs, Sep 1968	*None
17.	T/W"A", 75' x 750' Fac. No. 1925	Rigid - Heavy 16-18"	1956	a. Same as (1) except no painting and 9a b. Same as 1c and 7c	*None
18.	Primary R/W ends 2 x 1000' x 300' Fac. No. 1917	Rigid - Heavy 16" - 18"	1957	a. Same as 1a, 1b, and 1c	*None
19.	NW-SE 11-29 R/W Interior-outside edges 100' x 11,200' x 2 Fac. No. 1923	Flex - Heavy 4"	1958	a. Same as 1b, 1c, 3a and 7c b. Crack Seal - MC-250 May-Jun 67 I.H. c. Crack Seal - MC-250 May-Jun 68 I.H. d. Crack Seal - MC-250 May-Jun 69 I.H. e. Crack Rep MIN 49-8 A/F Shldr Oct 70.	MIN 75-2 Sand Seal FY72 MIN 3-6 Sand Seal FY76
20.	Shoulders 553, 570 sy Fac. No. 1922	Flex- Light 2" Non-Traffic	1956-7-8	a. Same as No. 19	MIN 14-3 Sand Seal FY73 MIN 3-6 Sand Seal FY76
21.	ADC Power Check Pad 50' Radius, Fac. No. 2030 Access Shldrs 2 - 10'x80'	Rigid - Light 10" 6" PCC w/10"BC	1963 1970	*None	*None
22.	Load-Unload Fac. 30'x250' rectangle with 125' R half-circle each side Fac. No. 2073 Access	Rigid - Light 9" Flex - Light 3"	1965	*None	*None
23.	Missile Site Heli-ports, 14 at LCF's 50' x 50' x 14 260' x 15' x 14 shoulders 98' x 10' access	Bit. Penta-Prime 6 6" 2" 2"	1969	a. MIN 267-0, E-1 & F-1; MIN 269-0, N-1 & O-1; MIN 273-0, J-1 & K-1; MIN 275-0, A-1 & B-1; MIN 278-0, L-1 & M-1; MIN 281-0, G-1 & I-1. DB. Bit. SF. Trt & 2" AC Center, Sep 70.	